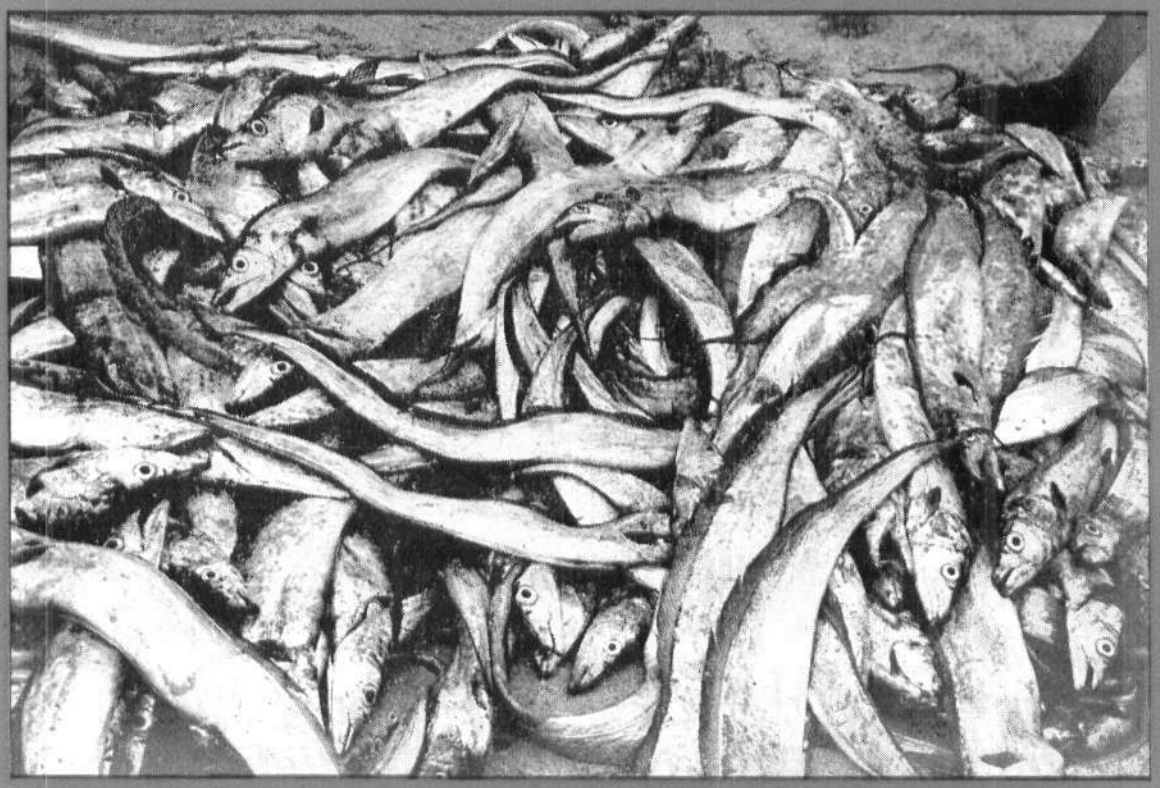
MARINE FISHERIES INFORMATION SERVICE



No. 87
SEPTEMBER 1988

Technical and Extension Series

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
COCHIN, INDIA

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the National Marine Living Resources Data Centre (NMLRDC) and the Research Divisions of the Institute, results of proven researches for transfer of technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

Abbreviation – *Mar. Fish. Infor. Serv., T & E Ser.,* No. 87: 1988

CONTENTS

1. Marine fish calendar. IX. Vizhinjam

2. Prawn fishing by the 'Big Trawlers' along the northeast coast

3. Successful induced spawning and rearing of the holothurian *Holothuria (Metriatyla) scabra* Jaeger at Tuticorin

Front cover photo:

Ribbon fish *(Trichiurus* sp.*)* – a common fish resource of Vizhinjam.

Back cover photo:

A busy fish landing centre at Vizhinjam.

MARINE FISH CALENDAR

IX. VIZHINJAM*

P. N. Radhakrishnan Nair, N. Gopalakrishna Pillai, P. S. Sadasiva Sharma, A. K. Velayudhan, Mathew Joseph, K. T. Thomas and T. A. Omana

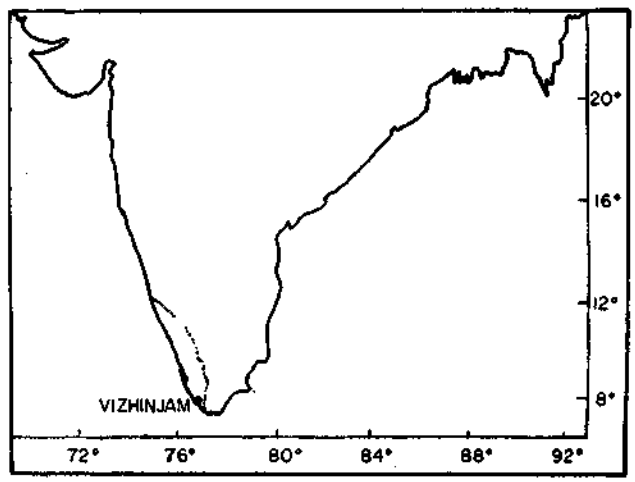
Vizhinjam Research Centre of CMFRI, Vizhinjam

Introduction

The fishery investigations in various parts of India have established that there are divergence in the pattern of species distribution and their abundance in these regions. Such changes are also noticed annually at a particular region as well as between closely adjacent centres of the same region. Therefore certain trends and patterns in seasons and abundance of the major fisheries become apparent from prolonged observations. Data collected over a period of five years, from 1981 to 1985, from the landing centre at Vizhinjam have been analysed to draw up a general fishery calendar suitable for this centre elucidating the cyclic changes in the abundance and dominance of the commercially important species/ groups of fish within a year.

Vizhinjam, 16 km, south of Trivandrum in Kerala State (Lat. 8°22' 30" N, Long. 76°59' 15" E), is an important fish landing centre in the fishery zone extending from Kollangode in the south to Valiaveli in the north spreading over a distance of 50 km on the southwest coast of India. Owing to the bay protected by breakwaters, which affords facilities for launching the boats into the sea even in the peak monsoon, fishing activity takes place in Vizhinjam area all through the year. Moreover the Vizhinjam Fishing Harbour, which is underway provides facilities for safe launching and harbouring of the crafts as well as landing of the catch. Good marketing outlets are available at nearby places such as Trivandrum, Balaramapuram and adjacent towns. The fishery is artisanal, employing catamaran, dugout canoe, plankbuilt boat and indigenous gears such as boat seine ('Thattumadi'), drift net ('Pattu vala'), hooks and line ('Choonda') *etc*. Neither trawling nor purse seining is being carried out at this centre. Mechanisation came very late to Vizhinjam, while in the nearby places like Sakthikulangara and Kolachal mechanised fishing had been well established even years back. Vizhinjam fishermen were rather cautiously avoiding mechanised fishing since they feared that favouring mechanisation may invite big businessmen into the field which may adversely affect the traditional fishing sector. However, in 1981 a few small mechanised boats have started operating in this area using traditional drift nets. But only a few fishermen could afford to the high capital investment and operational costs. By about September, 1982, five traditional crafts fitted with outboard motors started operating from Vizhinjam. Due to the high profit obtained by the fishermen and low capital and operational costs for the outboard motor when compared to those of mechanised boats, the mechanisation of traditional crafts with outboard motor became acceptable to the fishermen. In the course of past five years the total number of outboard motors at this centre increased to about 400. This trend is bound to continue, in view of the prospect of the fishing harbour under construction.

Mechanised craft generally go about 20–25 km off Vizhinjam to area of 60–80 m depth, whereas the



* Consolidated by N. Gopinatha Menon and K. Balachandran, CMFRI, Cochin.

non-mechanised crafts are confined to about 10 km from the shore and a depth range of 40–50 m. The number of actual fishing days in a month ranged from 20 to 25 for both the types of units.

The data collected from 1981 to 1985 have been processed for the preparation of the calendar. The data show that the annual marine fish landings (fin fish alone) at Vizhinjam ranged from 5,207.01 t in 1981 to 9,726.2 t in 1985 with the annual average landings at 6,374.41 t. The average monthly landings varied from 147.88 t in January to 1,230.05 t in July with the overall monthly average at 531.2 t. Fish landings higher than this monthly average were obtained during June to October, when nearly 71.3% of the annual catch was landed. It may be seen that the fishing effort was fairly high from May to October and there was also a corresponding increase in the catch and catch rate in these months. The highest catch (1,230.05 t) and catch rate (67.22 kg) were observed during July. From the foregoing trend it may be stated that June to October presents the main fishing season with best return in July in the Vizhinjam area. A large variety of fishes support the fishery at Vizhinjam and the landings of each gear have a characteristic species composition.

At present ten types of traditional gears are employed in Vizhinjam area to exploit its fishery resources. Of these boat seine, hooks and line, 'achil' (a tape of hand line with smaller hooks) and shore seine together contribute to the bulk (74.87%) of the total fish landings and the rest (25.13%) by gill nets which include drift net, 'chala vala', 'netholi vala', 'kolachi vala', 'konchu vala' and 'nandu vala'.

Apart from those species mentioned in this calendar, a number of species of fishes, which formed stray catches showing no regular fishery and were quite insignificant as independent fishery, also contributed to the fishery.

In addition to these, the juveniles of almost all major commercially important fishes formed a minor fishery locally called 'Nonna' fishery. This contributed to 0.03%. The fishery season extended from October to August. The average annual catch was 2.134 t with monthly catch ranging from 4 kg in October to 451 kg in August.

AMBASSIDAE

Popular English Name	:	Glassy perchlets
Vernacular Name (Malayalam)	:	'Mulli'
Annual average catch	:	5.7 t
Percentage in total catch	:	0.09
Fishing methods and their contribution	:	Boat seine : 0.08%
		Shore seine : 0.01%

ATHERINIDAE

Popular English Name	:	Hardy heads
Vernacular Name (Malayalam)	:	'Therani'
Annual average catch	:	2.8 t
Percentage in total catch	:	0.04
Fishing methods and their contribution	:	Boat seine: —
		Shore seine: —

BALISTIDAE

Popular English Name	:	File fish
Vernacular Name (Malayalam)	:	'Clathi'
Annual average catch	:	43.1 t
Percentage in total catch	:	0.67
Fishing methods and their contribution	:	Hooks & line: 0.67%

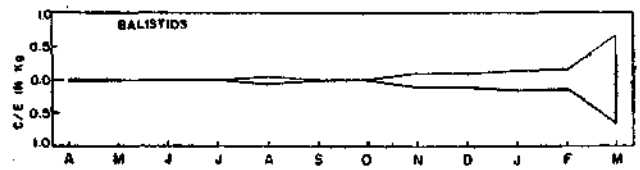


Fig. 1. Seasonal abundance of balistids at Vizhinjam.

BELONIDAE

Popular English Name	:	Needle fish/ Gar fishes
Vernacular Name (Malayalam)	:	'Kozhiyan mural'
Annual average catch	:	19.8 t
Percentage in total catch	:	0.31
Fishing methods and their contribution	:	Hooks & line: 0.17%
		Drift net : 0.14%

CARANGIDAE

Popular English Name	:	Trevallies/Horse mackerel/ Queenfish/Darts
Vernacular Name (Malayalam)	:	'Para'
Annual average catch	:	986.0 t
Percentage in total catch	:	15.47

Fishing methods and their contribution : Drift net: 2.49%
Chala vala: 0.19%
Konchu vala: 0.37%
Hooks & line: 9.92%
Boat seine : 2.40%
Shore seine: 0.11%

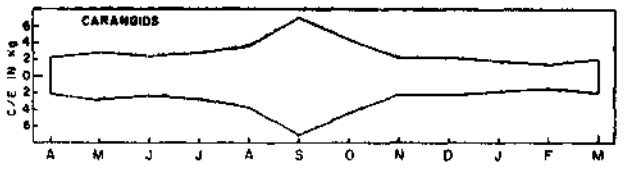


Fig. 2. Seasonal abundance of carangids at Vizhinjam.

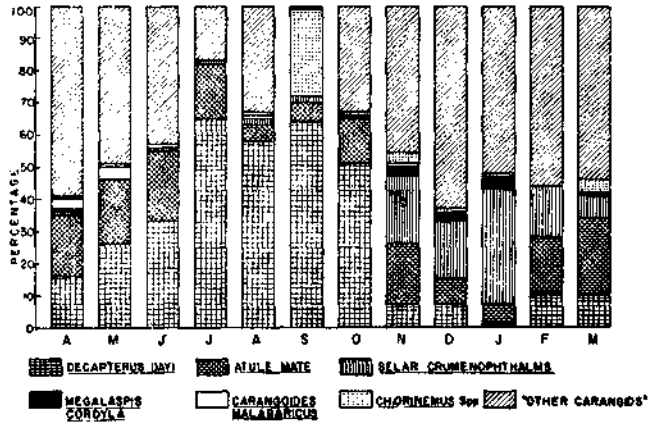


Fig. 3. Monthwise species composition of carangids in indigenous gears.

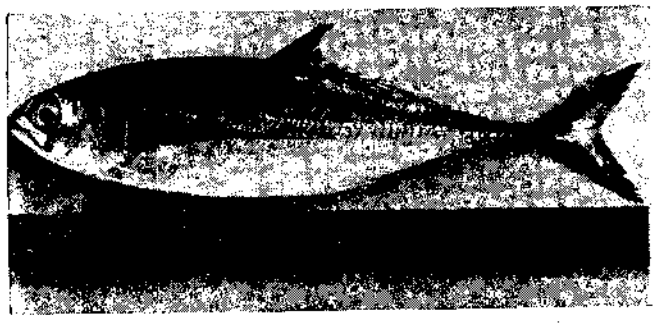


Fig. 4. *Megalaspis cordyla.*

Scientific Name	:	*Megalaspis cordyla*
Vernacular Name	:	'Vankada'
Gear	:	Drift net/Hooks & line/Shore seine/ Boat seine
Peak period of occurrence	:	Oct. – Jan.
Depth of occurrence	:	40 – 60 m
Length range in commercial fishery	:	130 – 374 mm
Size at first maturity	:	—
Spawning season	:	Nov. – Dec.

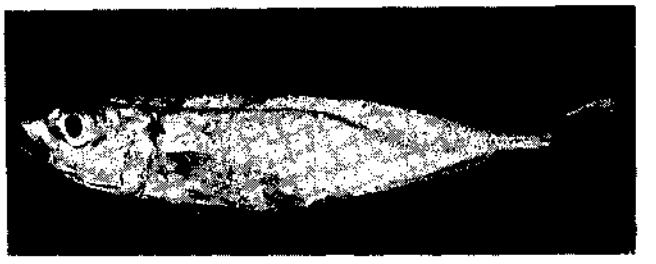


Fig. 5. *Decapterus dayi*

Scientific Name	:	*Decapterus dayi*
Vernacular Name	:	'Kozhiyala'
Gear	:	Hooks & line/ Chala vala/Boat seine/Shore seine/ Konchu vala
Peak period of occurrence	:	May – Oct.
Depth of occurrence	:	15 – 60 m
Length range in commercial fishery	:	60 – 229 mm
Size at first maturity	:	130 mm
Spawning season	:	Mar. – May and Aug.–Oct.

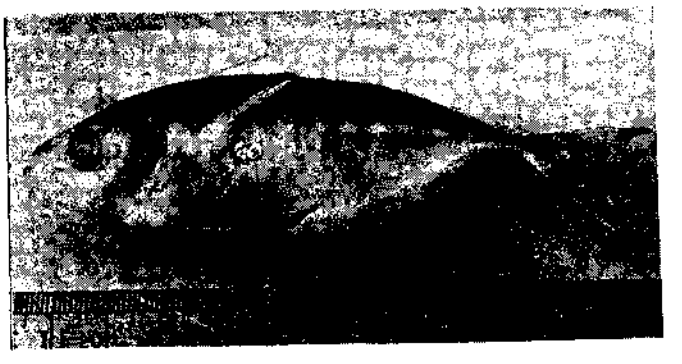


Fig. 6. *Atule mate.*

Scientific Name	:	*Atule mate*
Vernacular Name	:	'Urula para'
Gear	:	Drift net/Chala vala/Konchu vala/ Hooks & line/ Boat seine/ Shore seine
Peak period of occurrence	:	Mar. – July and Sep. – Nov.

Depth of occurrence	:	30 - 60 m
Length range in commercial fishery	:	100 - 314 mm
Size at first maturity	:	—
Spawning season	:	Apr. - Jul.

Fig. 7. *Carangoides malabaricus.*

Scientific Name	:	*Carangoides malabaricus*
Vernacular Name	:	'Vattakkanni para'
Gear	:	Hooks & line/ Drift net/ Konchu vala
Peak period of occurrence	:	Apr. - May and Oct.
Depth of occurrence	:	30 - 60 m
Length range in commercial fishery	:	110 - 215 mm
Size at first maturity	:	—
Spawning season	:	—

CHIROCENTRIDAE

Popular English Name	:	Wolf-herrings
Vernacular Name (Malayalam)	:	'Mulluvaala'
Annual average catch	:	22.2 t
Percentage in total catch	:	0.35
Fishing methods and their contribution	:	Drift net: 0.18% Hooks & line: 0.04% Chala vala: 0.10% Konchu vala: 0.03%

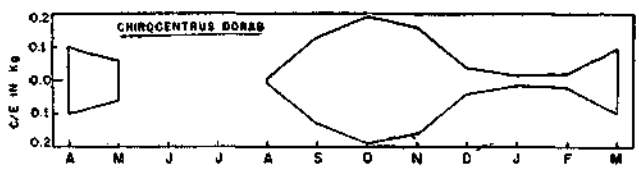


Fig. 8. Seasonal abundance of chirocentrids at Vizhinjam.

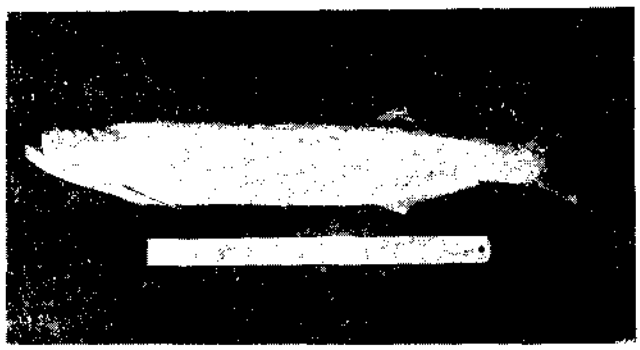


Fig. 9. *Chirocentrus dorab.*

Scientific Name	:	*Chirocentrus dorab*
Vernacular Name	:	'Mulluvaala'
Gear	:	Gill net
Peak period of occurrence	:	Aug. - May and Sep. - Nov.
Depth of occurrence	:	30 - 60 m
Length range in commercial fishery	:	—
Size at first maturity	:	—
Spawning season	:	—

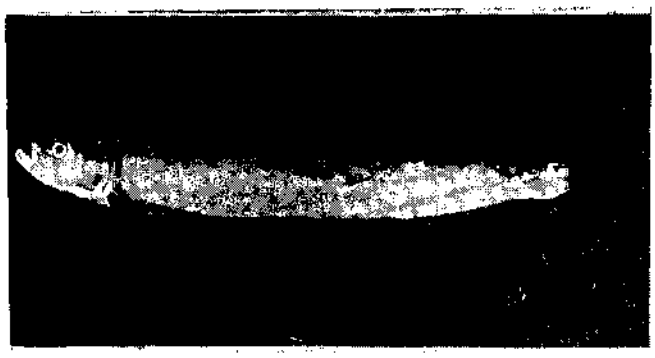


Fig. 10. *Chirocentrus nudus.*

Scientific Name	:	*Chirocentrus nudus*
Vernacular Name	:	'Mulluvaala'
Gear	:	Gill net
Peak period of occurrence	:	Aug. - May and Sep. - Nov.
Depth of occurrence	:	30 - 60 m
Length range in commercial fishery	:	—
Size at first maturity	:	—
Spawning season	:	—

CLUPEIDAE

Popular English Name	:	Sardines
Vernacular Name (Malayalam)	:	'Chala'

Annual average catch	:	312.01 t
Percentage in total catch	:	4.89
Fishing methods and their contribution	:	Chala vala: 4.14% Shore seine: 0.15% Hooks & line: 0.07% Boat seine: 0.53%

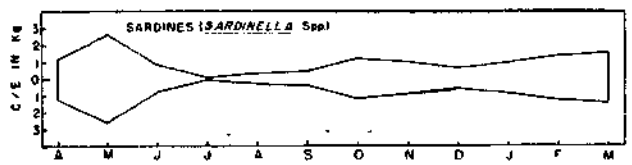


Fig. 11. Seasonal abundance of sardines at Vizhinjam.

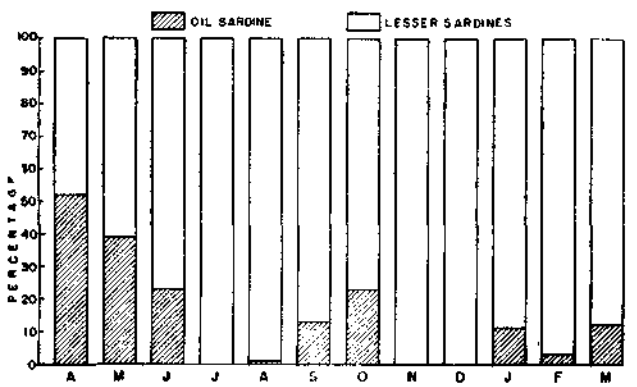


Fig. 12. Monthwise species composition of clupeids in indigenous gears at Vizhinjam.

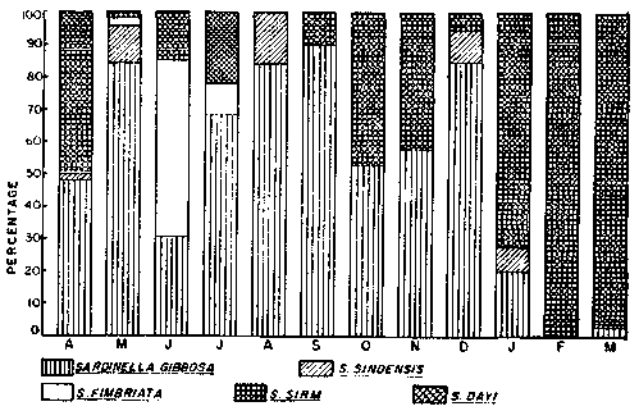


Fig. 13. Monthwise species composition of lesser sardines in indigenous gears at Vizhinjam.

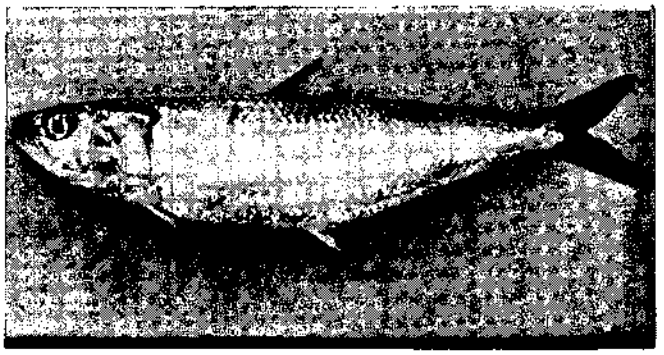


Fig. 14. *Sardinella longiceps.*

Scientific Name	:	*Sardinella longiceps*
Vernacular Name	:	'Nei-chala'
Gear	:	Chalavala/Shore seine/Hooks & line
Peak period of occurrence	:	Mar.–Jun.
Depth of occurrence	:	Up to 40 m
Length range in commercial fishery	:	88 - 224 mm
Size at first maturity	:	—
Spawning season	:	Apr. – May and Sep. – Oct.

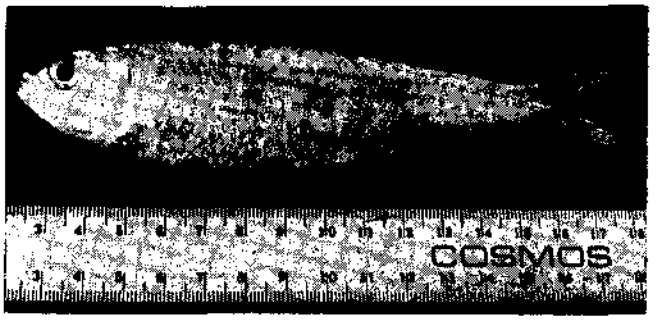


Fig. 15. *Sardinella gibbosa.*

Scientific Name	:	*Sardinella gibbosa*
Vernacular Name	:	'Chala'
Gear	:	Chala vala/Shore seine/Hooks & line
Peak period of occurrence	:	Jan. – Jun.
Depth of occurrence	:	Upto 20 m
Length range in commercial fishery	:	84 – 194 mm
Size at first maturity	:	—
Spawning season	:	Apr. – Aug.

Fig. 16. *Sardinella fimbriata.*

Scientific Name	:	*Sardinella fimbriata*
Vernacular Name	:	'Karichala'
Gear	:	Chala vala
Peak period of occurrence	:	Apr. – Jul.
Depth of occurrence	:	Upto 30 m
Length range in commercial fishery	:	120 – 189 mm
Size at first maturity	:	—
Spawning season	:	—

CORYPHAENIDAE

Popular English Name	:	Dolphin fish
Vernacular Name (Malayalam)	:	'Palameen'
Annual average catch	:	24.6 t
Percentage in total catch	:	0.39
Fishing methods and their contribution	:	Hooks & line: 0.37%
		Drift net: 0.02%

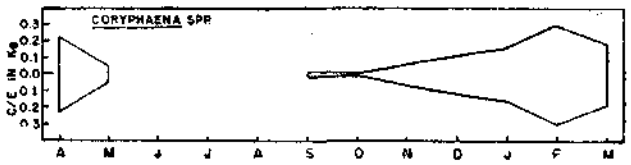


Fig. 17. Seasonal abundance of dolphin fish at Vizhinjam.

CYNOGLOSSIDAE

Popular English Name	:	Soles/Flat fishes
Vernacular Name (Malayalam)	:	'Nilampathungi'/ 'Erumanakku'
Annual average catch	:	5.5 t
Percentage in total catch	:	0.09
Fishing methods and their contribution	:	Boat seine : 0.08%
		Konchu vala: 0.01%

DUSSUMIERIDAE

Popular English Name	:	Rainbow sardine
Vernacular Name (Malayalam)	:	'Mopal'/ 'Muthupolappan'/ 'Kokkola'
Annual average catch	:	149.0 t
Percentage in total catch	:	2.33
Fishing methods and their contribution	:	Chala vala: 0.13%
		Boat seine: 1.05%
		Shore seine: 0.02%
		Hooks & line: 1.13%
		Konchu vala: 0.01%

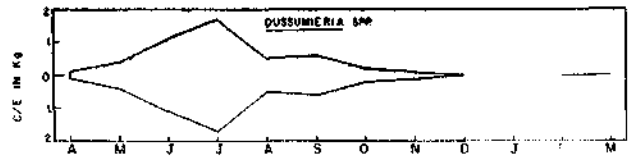


Fig. 18. Seasonal abundance of rainbow sardines at Vizhinjam.

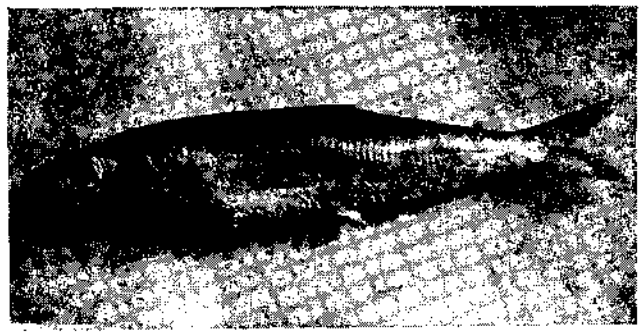


Fig. 19. *Dussumieria hasseltii.*

Scientific Name	:	*Dussumieria hasseltii*
Vernacular Name	:	'Moral'/ 'Muthupolappan'/ 'Kokkola'
Gear	:	Chala vala/Boat seine/Hooks & line
Percentage composition in the gear	:	—
Peak period of occurrence	:	May – Sep.
Depth of occurrence	:	Upto 40 m
Length range in commercial fishery	:	80 – 224 mm
Size at first maturity	:	170 mm
Spawning season	:	—

ELASMOBRANCHS

Popular English Name : Sharks/Rays/Skates
Vernacular Name (Malayalam) : 'Sravu'/'Therachi'/'Poonthi'
Annual average catch : 82.9 t
Percentage in total catch : 1.3
Fishing methods and their contribution : Hooks and line: 0.37%
Drift net: 0.64%
Boat seine: 0.19%
Shore seine: 0.01%
Konchu vala: 0.09%

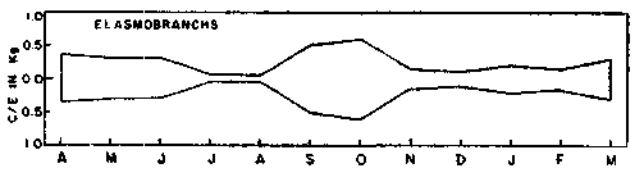


Fig. 20. Seasonal abundance of elasmobranchs at Vizhinjam.

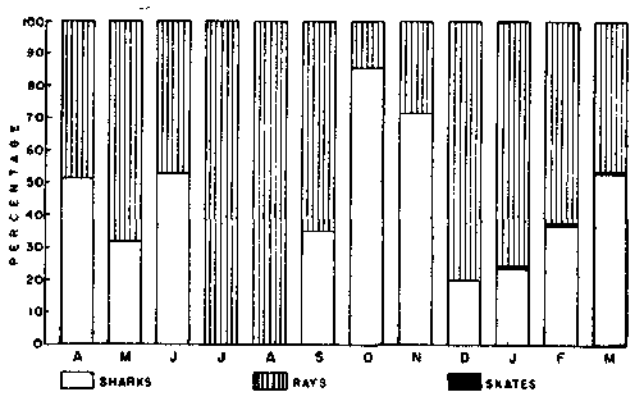


Fig. 21. Monthwise species composition of elasmobranchs at Vizhinjam.

ENGRAULIDAE

Popular English Name : Anchovy
Vernacular Name (Malayalam) : 'Netholi'
Annual average catch : 727.3 t
Percentage in total catch : 11.41
Fishing methods and their contribution : Netholi vala: 1.18%
Boat seine: 10.05%
Shore seine: 0.13%
Chala vala: 0.03%
Konchu vala: 0.02%

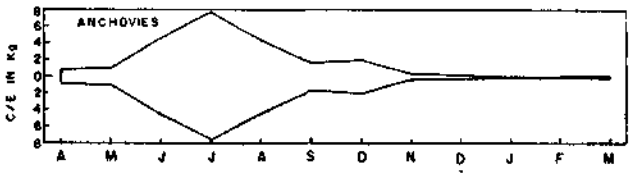


Fig. 22. Seasonal abundance of anchovies at Vizhinjam.

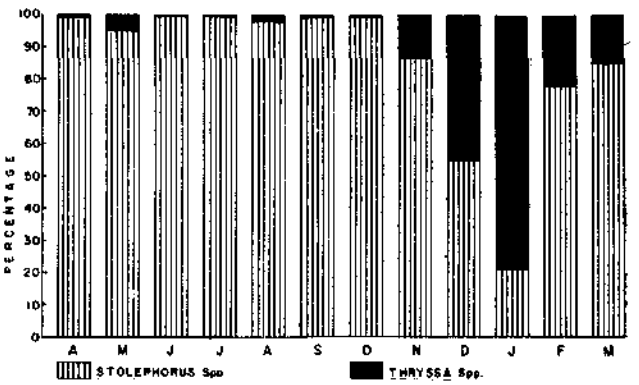


Fig. 23. Monthwise composition of *Stolephorus* and *Thryssa* in indigenous gears at Vizhinjam.

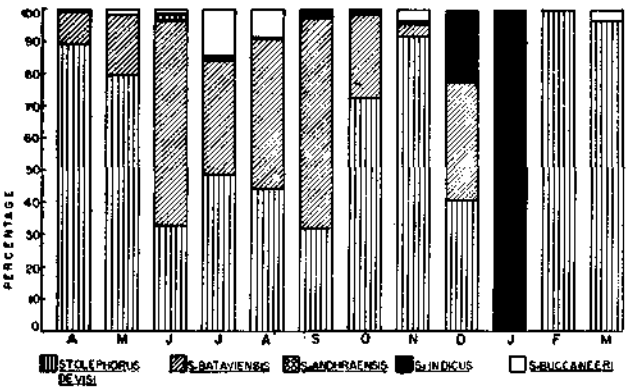


Fig. 24. Monthwise species composition of anchovies in indigenous gears at Vizhinjam.

Fig. 25. *Stolephorus indicus*.

Scientific Name	:	*Stolephorus indicus*
Vernacular Name	:	'Netholi'
Gear	:	Boat seine/Shore seine/Netholi vala (Gill net)
Peak period of occurrence	:	Aug. – Oct.
Depth of occurrence	:	5 - 15 m
Length range in commercial fishery	:	70 – 149 mm
Size at first maturity	:	120 mm
Spawning season	:	Oct. - Jun.

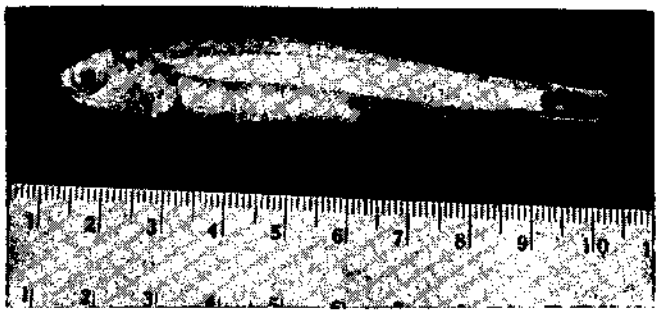


Fig. 26. *Stolephorus devisi.*

Scientific Name	:	*Stolephorus devisi*
Vernacular Name	:	'Netholi'
Gear	:	Netholi vala/Boat seine/Shore seine
Peak period of occurrence	:	Apr. – Nov.
Depth of occurrence	:	5 - 15 m
Length range in commercial fishery	:	30 - 140 mm
Size at first maturity	:	60 mm
Spawning season	:	Extended spawner

Fig. 27. *Stolephorus bataviensis.*

Scientific Name	:	*Stolephorus bataviensis*
Vernacular Name	:	'Manja netholi'
Gear	:	Netholi vala/ Boat seine/Shore seine
Peak period of occurrence	:	May - Oct.
Depth of occurrence	:	Upto 15 m
Length range in commercial fishery	:	45 – 109 mm
Size at first maturity	:	75 mm
Spawning season	:	Extended spawner

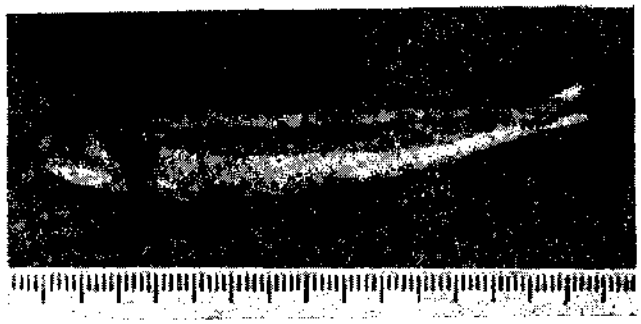


Fig. 28. *Stolephorus buccaneeri.*

Scientific Name	:	*Stolephorus buccaneeri*
Vernacular Name	:	'Karu netholi'
Gear	:	Netholi vala/ Boat seine/Shore seine
Peak period of occurrence	:	Jul. –Aug.
Depth of occurrence	:	5 – 15 m
Length range in commercial fishery	:	30 – 99 mm
Size at first maturity	:	45 mm
Spawning season	:	Oct. -Jun.

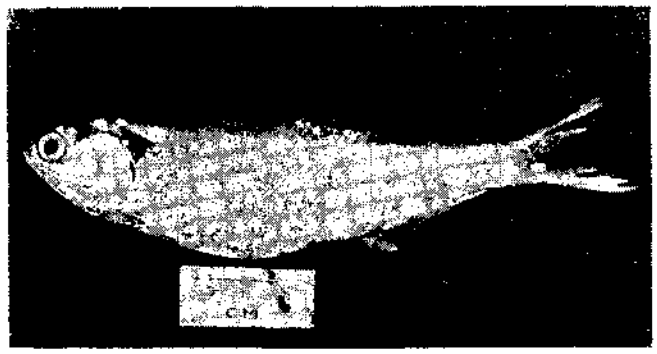


Fig. 29. *Thryssa mystax.*

Scientific Name	:	*Thryssa mystax*
Vernacular Name	:	'Kootal'
Gear	:	Shore seine/Boat seine/Konchu vala/ Chala vala
Peak period of occurrence	:	—
Depth of occurrence	:	—

Length range in commercial fishery : —
Size at first maturity : —
Spawning season : —

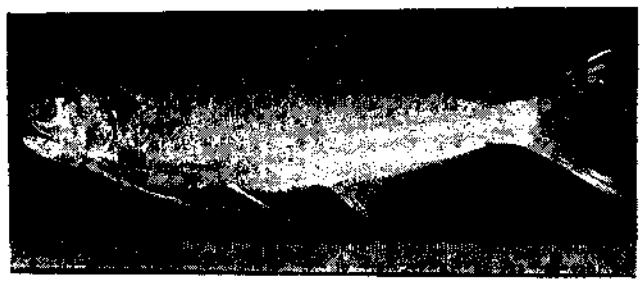


Fig. 30. *Thryssa setirostris.*

Scientific Name : *Thryssa setirostris*
Vernacular Name : 'Kootal'
Gear : Shore seine/Boat seine/Konchu vala/ Chala vala
Peak period of occurrence : May, Aug. and Dec.
Depth of occurrence : Upto 30 m
Length range in commercial fishery : 85 – 170 mm
Size at first maturity : —
Spawning season : Nov. - Dec.

Hemiramphidae

Popular English Name : Half-beak
Vernacular Name (Malayalam) : 'Kolachi'/ 'Ottachundan kola'
Annual average catch : 2.6 t
Percentage in total catch : 0.04
Fishing methods and and their contribution : Kolachi vala: 0.04%

Holocentridae

Popular English Name : Squirrel fish
Vernacular Name (Malayalam) : 'Katantha mulli'
Annual average catch : 0.3 t
Percentage in total catch : —
Fishing methods and their contribution : Hooks & line/ Drift net: —

Istiophoridae

Popular English Name : Sail-fish
Vernacular Name (Malayalam) : 'Thala'
Annual average catch : 30.9 t
Percentage in total catch : 0.48
Fishing methods and their contribution : Hooks & line: 0.42%
Drift net: 0.06%

Lactaridae

Popular English Name : White fish
Vernacular Name (Malayalam) : 'Parava'
Annual average catch : 12.6 t
Percentage in total catch : 0.20
Fishing methods and their contribution : Boat seine: 0.17%
Konchu vala: 0.03%

Leiognathidae

Popular English Name : Silver bellies
Vernacular Name (Malayalam) : 'Karal'
Annual average catch : 167.7 t
Percentage in total catch : 3.95
Fishing methods and their contribution : Boat seine: 3.39%
Shore seine: 0.12%
Chala vala: 0.37%
Konchu vala: 0.07%

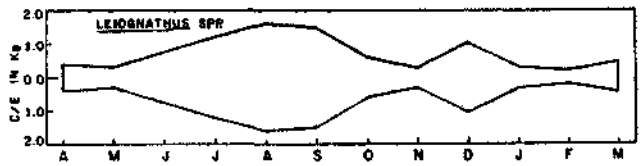


Fig. 31. Seasonal abundance of silver bellies at Vizhinjam.

Lethrinidae

Popular English Name : Pigface-breams/ Emperor-breams
Vernacular Name (Malayalam) : 'Velameen'
Annual average catch : 37.8 t
Percentage in total catch : 0.59
Fishing methods and their contribution : Hooks & line: 0.34%
Drift net: 0.21%
Boat seine: 0.03%

LUTJANIDAE

Popular English Name : Snapper job fishes
Vernacular Name (Malayalam) : 'Chempalli'
Annual average catch : 33.2 t
Percentage in total catch : 0.52
Fishing methods and their contribution : Hooks & line: 0.31%
Drift net: 0.14%
Konchu vala: 0.04%
Boat seine: 0.02%

MENIDAE

Popular English Name : Moon fishes
Vernacular Name (Malayalam) : 'Kannadi karal'
Annual average catch : 1.9 t
Percentage in total catch : 0.03
Fishing methods and their contribution : Boat seine: 0.03%

MUGILIDAE

Popular English Name : Mullets
Vernacular Name (Malayalam) : 'Mala'/'Kanambu'
Annual average catch : 24.1 t
Percentage in total catch : 0.38
Fishing methods and their contribution : Boat seine: 0.37%

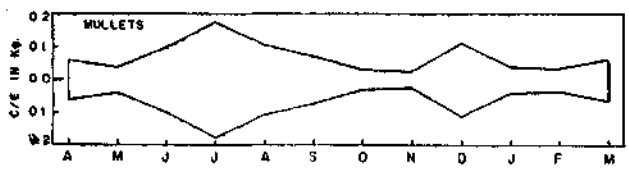


Fig. 32. Seasonal abundance of mullets at Vizhinjam.

MULLIDAE

Popular English Name : Goat fishes
Vernacular Name (Malayalam) : 'Nakara'/ 'Kilivarnadu'
Annual average catch : 5.5 t
Percentage in total catch : 0.09
Fishing methods and their contribution : Boat seine: 0.05%
Konchu vala: 0.04%

NEMIPTERIDAE

Popular English Name : Threadfin bream
Vernacular Name (Malayalam) : 'Kilimeen'
Annual average catch : 167.7 t
Percentage in total catch : 2.63
Fishing methods and their contribution : Hooks & line: 2.55%
Boat seine: 0.05%
Gill net: 0.04%

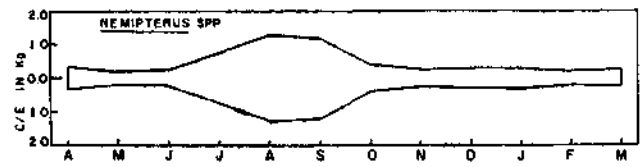


Fig. 33. Seasonal abundance of threadfin breams at Vizhinjam.

PLATYCEPHALIDAE

Popular English Name : Flat-heads
Vernacular Name (Malayalam) : 'Oratha'
Annual average catch : 27.8 t
Percentage in total catch : 0.44
Fishing methods and their contribution : Konchu vala: 0.39%
Hooks & line: 0.02%
Boat seine: 0.01%
Drift net: 0.03%

POMADASYIDAE

Popular English Name : Grunters
Vernacular Name (Malayalam) : 'Cheymeen'
Annual average catch : 5.1 t
Percentage in total catch : 0.08
Fishing methods and their contribution : Hooks & line: 0.01%
Konchu vala: 0.06%
Boat seine: 0.01%

PRIACANTHIDAE

Popular English Name : Bull's eye
Vernacular Name (Malayalam) : 'Kanna pola'
Annual average catch : 29.8 t
Percentage in total catch : 0.47

Fishing methods and their contribution : Drift net: 0.20%
Hooks & line: 0.27%

SCIAENIDAE

Popular English Name : Croackers
Vernacular Name (Malayalam) : 'Tora'
Annual average catch : 96.5 t
Percentage in total catch : 1.51
Fishing methods and their contribution : Boat seine: 1.07%
Shore seine: 0.04%
Hooks & line: 0.07%
Konchu vala: 0.33%

SCOMBRIDAE

Popular English Name : Tunas/Seer fishes/ Mackerel
Vernacular Name (Malayalam) : 'Choora'/'Neimeen'/ 'Ayila'
Annual average catch : 1,172.6 t
Percentage in total catch : 18.4
Fishing methods and their contribution : Hooks & line: 9.7%
Drift net: 8.4%
Konchu vala: 0.2%
Shore seine: 0.1%

TUNAS

Popular English Name : Tuna
Vernacular Name (Malayalam) : 'Choora'
Annual average catch : 802.4 t
Percentage in total catch : 12.58
Fishing methods and their contribution : Hooks & line: 8.9%
Drift net: 3.7%

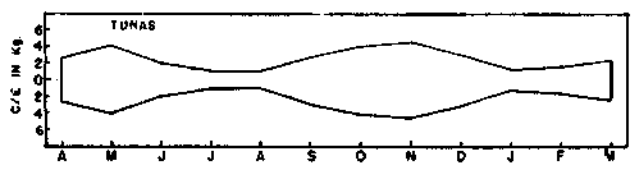


Fig. 34. Seasonal abundance of tunas at Vizhinjam.

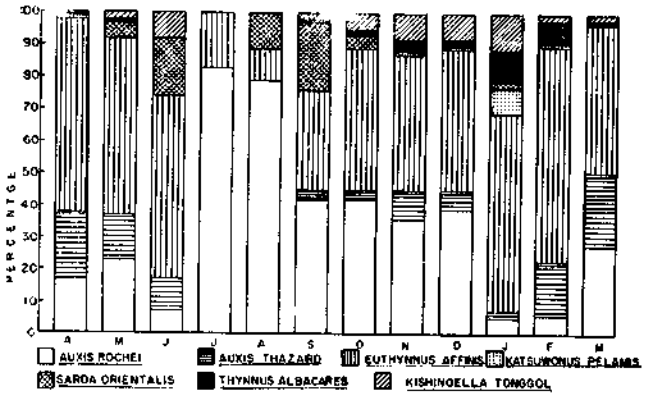


Fig. 35. Monthwise species composition of tunas in indigenous gears at Vizhinjam.

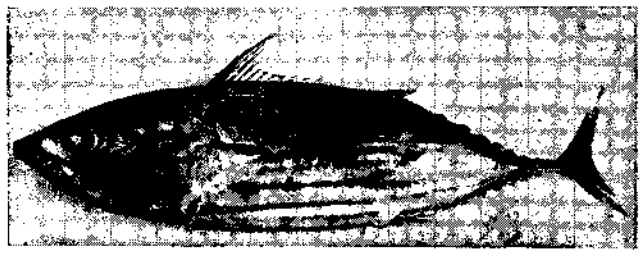


Fig. 36. *Katsuwonus pelamis.*

Scientific Name : *Katsuwonus pelamis*
Vernacular Name : 'Varichoora'
Gear : Hooks & line/ Drift net
Peak period of occurrence : Jan.
Depth of occurrence : 40-60 m
Length range in commercial fishery : —
Size at first maturity : —
Spawning season : —

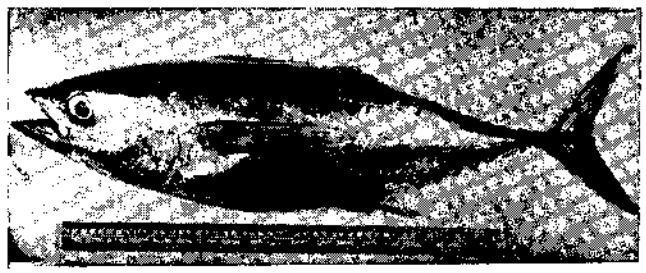


Fig. 37. *Thunnus albacares.*

Scientific Name : *Thunnus albacares*
Vernacular Name : 'Paduvattu choora'
Gear : Hooks & line/ Drift net

Peak period of occurrence	:	Oct. – Feb.
Depth of occurrence	:	40 – 60 m
Length range in commercial fishery	:	400 – 800 mm
Size at first maturity	:	—
Spawning season	:	—

Fig. 38. *Euthynnus affinis.*

Scientific Name	:	*Euthynnus affinis*
Vernacular Name	:	'Kerachoora'
Gear	:	Hooks & line/ Drift net
Peak period of occurrence	:	Sep. – Jun.
Depth of occurrence	:	40 – 60 m
Length range in commercial fishery	:	280 – 720 mm
Size at first maturity	:	—
Spawning season	:	—

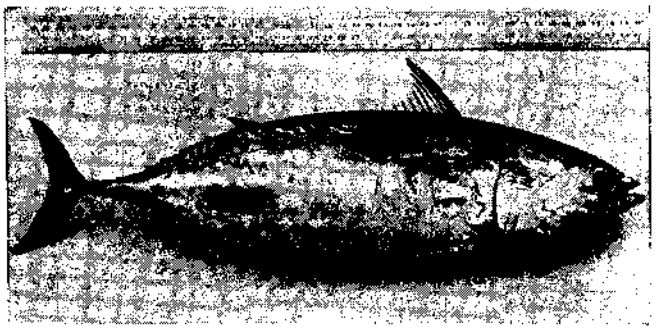


Fig. 39. *Auxis thazard.*

Scientific Name	:	*Auxis thazard*
Vernacular Name	:	'Elichoora'
Gear	:	Hooks & line/ Drift net
Peak period of occurrence	:	Feb. – Jun. and Sep. –Dec.
Depth of occurrence	:	40 – 60 m
Length range in commercial fishery	:	260 – 400 mm
Size at first maturity	:	—
Spawning season	:	—

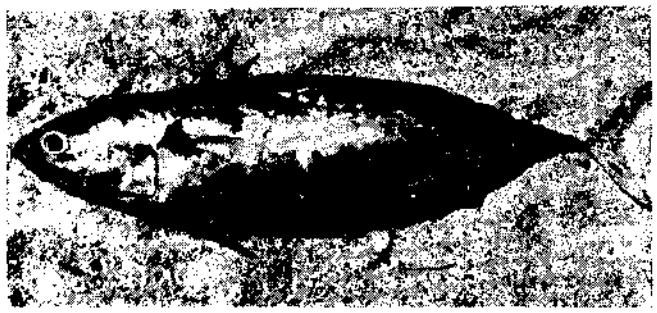


Fig. 40. *Auxis rochei.*

Scientific Name	:	*Auxis rochei*
Vernacular Name	:	'Urulan choora'
Gear	:	Hooks & line/ Drift net
Peak period of occurrence	:	Jul. – Dec.
Depth of occurrence	:	30 – 60 m
Length range in commercial fishery	:	180 – 280 mm
Size at first maturity	:	—
Spawning season	:	—

Seer Fishes

Popular English Name	:	Seer fishes
Vernacular Name (Malayalam)	:	'Neimeen'
Annual average catch	:	144.7 t
Percentage in total catch	:	2.27
Fishing methods and their contribution	:	Drift net: 2.20% Hooks & line: 0.01%

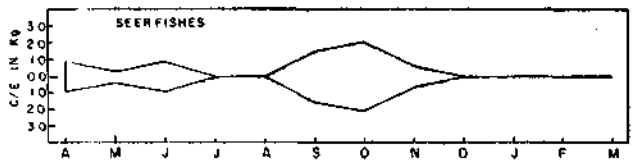


Fig. 41. Seasonal abundance of seer fishes at Vizhinjam.

Mackerel

Popular English Name	:	Indian mackerel
Vernacular Name (Malayalam)	:	'Ayila'
Annual average catch	:	225.5 t
Percentage in total catch	:	3.54

Fishing methods and their contribution : Drift net : 2.60%
Konchu vala: 0.17%
Hooks & line: 0.80%
Shore seine: 0.05%
Boat seine: 0.05%

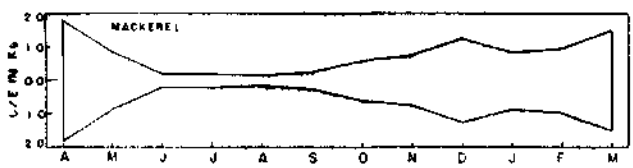


Fig. 42. Seasonal abundance of mackerel at Vizhinjam.

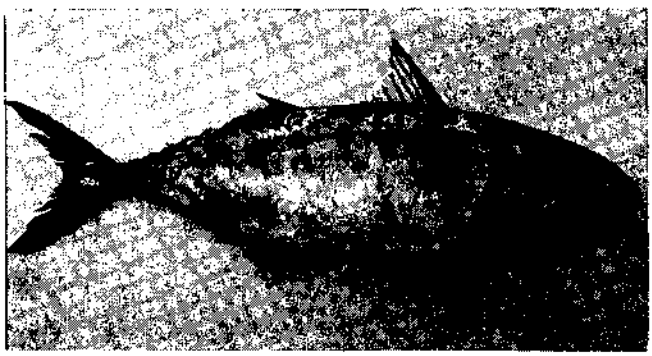


Fig. 43. *Rastrelliger kanagurta.*

Scientific Name	:	*Rastrelliger kanagurta*
Vernacular Name	:	'Ayila'
Gear	:	Hooks & line/ Shore seine/Boat seine/Drift net/ Chala vala/ Konchu vala
Peak period of occurrence	:	Nov. - May
Depth of occurrence	:	Upto 60 m
Length range in commercial fishery	:	65 – 300 mm
Size at first maturity	:	—
Spawning season	:	Mar. – Jun. and Sep. –Oct.

SERRANIDAE

Popular English Name	:	Rock cods
Vernacular Name (Malayalam)	:	'Kalava'
Annual average catch	:	14.7 t
Percentage in total catch	:	0.23
Fishing methods and their contribution	:	Drift net: 0.05%
		Hooks & line: 0.13%
		Boat seine: 0.05%

SILLAGINIDAE

Popular English Name	:	Whiting
Vernacular Name (Malayalam)	:	'Kilimeen'
Annual average catch	:	11.8 t
Percentage in total catch	:	0.18
Fishing methods and their contribution	:	Boat seine: 0.18%

SPHYRAENIDAE

Popular English Name	:	Barracudas
Vernacular Name (Malayalam)	:	'Seelavu'/'Neduva'
Annual average catch	:	61.0 t
Percentage in total catch	:	0.95
Fishing methods and their contribution	:	Drift net: 0.43%
		Chala vala: 0.08%
		Hooks & line: 0.09%
		Boat seine: 0.33%
		Shore seine: 0.01%

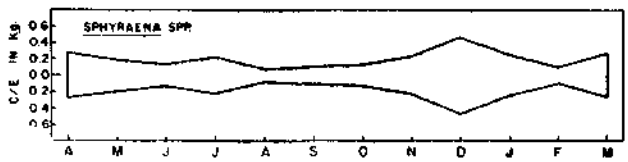


Fig. 44. Seasonal abundance of barracudas at Vizhinjam.

STROMATEIDAE

Popular English Name	:	Pomfrets
Vernacular Name (Malayalam)	:	'Avoli'
Annual average catch	:	14.6 t
Percentage in total catch	:	0.23
Fishing methods and their contribution	:	Boat seine : 0.09%
		Drift net : 0.14%

SYNODONTIDAE

Popular English Name	:	Lizard fishes
Vernacular Name (Malayalam)	:	'Arana meen'
Annual average catch	:	41.6 t
Percentage in total catch	:	0.65

Fishing methods and their contribution : Hooks & line: 0.51%
Konchu vala: 0.09%
Chala vala: 0.04%
Boat seine: 0.01%

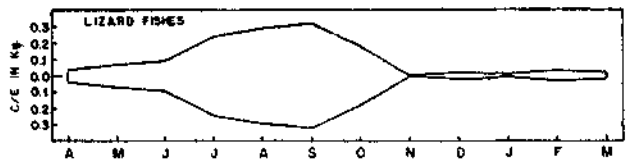


Fig. 45. Seasonal abundance of lizard fishes at Vizhinjam.

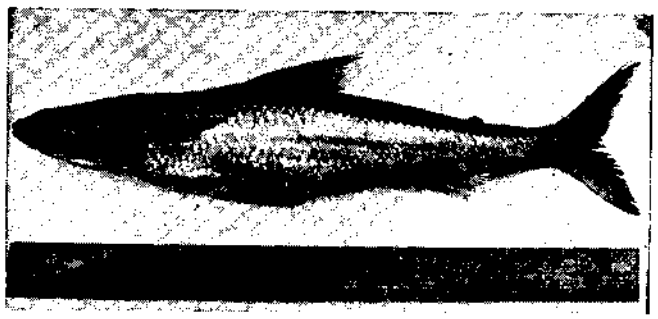


Fig. 46. *Saurida tumbil.*

Scientific Name : *Saurida tumbil*
Vernacular Name : 'Arana meen'
Gear : Hooks & line/ Chala vala/ Konchu vala
Peak period of occurrence : Jul. – Aug.
Depth of occurrence : 20 – 40 m
Length range in commercial fishery : 130 – 349 mm
Size at first maturity : —
Spawning season : Aug. – Sep.

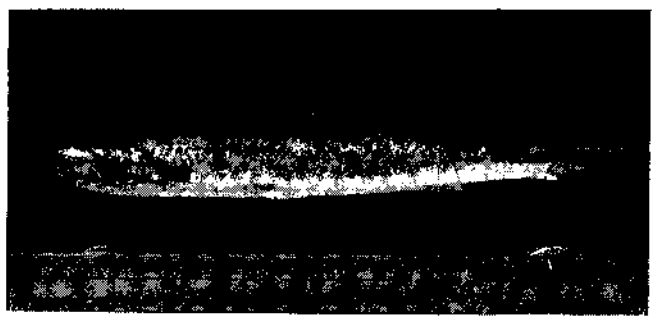


Fig. 47. *Saurida undosquamis.*

Scientific Name : *Saurida undosquamis*
Vernacular Name : 'Arana meen'
Gear : Chala vala/ Konchu vala/ Hooks & line
Peak period of occurrence : Feb. - Mar., May – Jun. and Sep. – Oct.
Depth of occurrence : 20 – 40 m
Length range in commercial fishery : 50 – 329 mm
Size at first maturity : —
Spawning season : Aug. –Sep.

TACHYSURIDAE

Popular English Name : Cat fishes
Vernacular Name (Malayalam) : 'Thedu'
Annual average catch : 85.4 t
Percentage in total catch : 1.34
Fishing methods and their contribution : Drift net : 0.26%
Hooks & line: 0.74%
Boat seine : 0.30%
Konchu vala: 0.04%

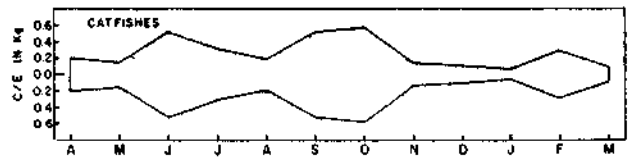


Fig. 48. Seasonal abundance of cat fishes at Vizhinjam.

THERAPONIDAE

Popular English Name : Thorn fish/ Crescent perch
Vernacular Name (Malayalam) : 'Keeli'
Annual average catch : 25.5 t
Percentage in total catch : 0.40
Fishing methods and their contribution : Hooks & line: 0.19%
Drift net: 0.02%
Konchu vala: 0.16%
Boat seine: 0.03%

TRICHIURIDAE

Popular English Name	:	Ribbon fishes
Vernacular Name (Malayalam)	:	'Vaala'/'Chunnambu vaala'
Annual average catch	:	1698.8 t
Percentage in total catch	:	26.65
Fishing methods and their contribution		Boat seine: 25.80%
		Hooks & line: 0.43%
		Drift net: 0.43%

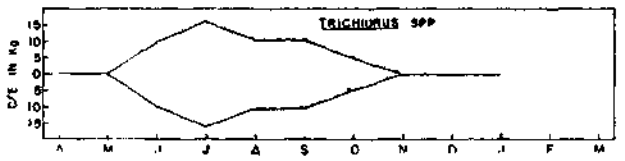


Fig. 49. Seasonal abundance of ribbon fishes at Vizhinjam.

Fig. 50. *Trichiurus lepturus.*

Scientific Name	:	*Trichiurus lepturus*
Vernacular Name	:	'Chunnambu vaala'
Gear	:	Boat seine
Peak period of occurrence	:	Jun. - Sep.
Depth of occurrence	:	15 - 40 m
Length range in commercial fishery	:	640 - 1130 mm
Size at first maturity	:	—
Spawning season	:	Jul. - Sep.

PRAWN FISHERY BY THE 'BIG TRAWLERS' ALONG THE NORTHEAST COAST

G. Sudhakara Rao
Visakhapatnam Research Centre of CMFRI, Visakhapatnam

Introduction

The traditional fishery for prawns along the northeast coast with different varieties of shore seines and boat seines has been restricted to a narrow strip of coastal waters. With the advent of mechanisation, the fishing pattern has undergone drastic changes in the past two decades. Commercial trawling for prawns by small mechanised boats of 10–11 m length with 45–70 HP diesel engines, started towards the end of 1967 at Visakhapatnam, has expanded by leaps and bounds. Some of these boats ventured fishing along the Orissa coast in 1973 met with success. Thus there developed a sizable fleet operating from Paradeep althrough the year. However, due to limited endurance these small mechanised boats are not capable of harvesting the vast areas of the Sandheads and the adjacent grounds. Two 'big trawlers' of 24 m over-all-length (Gulf of Mexico type) imported from the USA which started fishing for prawns in this area in 1972 found that this type of boats could be operated successfully in these waters. The economic viability of these two boats paved the way for the development of a fishery based on these big trawlers. In recent years there has been a gradual increase in the number of these boats and in 1986 about 100 big trawlers were in operation. Another interesting development was the introduction of 'mini trawlers' (16 m OAL) at the end of 1985 which became the craze of the industry in 1986. About 27 of these 'mini trawlers' were in operation in 1986 from

Visakhapatnam. These trawlers (large trawlers and mini trawlers) operate from Visakhapatnam since infrastructural facilities are available only at this harbour. Some of the boats operated from Roychowk harbour during 1983-'84 found it difficult to operate from this harbour and abandoned the idea once for all inspite of the requests from West Bengal. In fact, the vessels of the West Bengal Fisheries Corporation themselves are operating from Visakhapatnam.

Rao *(Indian J. Fish.,)* gave a preliminary account of the fishery based on the data of 1983-'84 to 1985-'86 and stock estimation of the prawn resource. In the present account data for 1983-'84 to 1986-'87 are analysed in a detailed way to eulcidate monthly variations as well as annual variations of catch and effort, catch composition, fishing areas and depth distribution.

The fishing fleet and its operations

The big trawlers of 22-25 m OAL are made of steel with 380-450 HP diesel engines while the mini trawlers of 16 m OAL are of wooden make with engines of 145 HP. Salient features of a typical big trawler and a typical mini trawler are given below:

Specifications	Big trawler	Mini trawler
Over-all-length (m)	23.19	16.00
Breadth (m)	7.33	5.08
Draft (m)	3.08	2.15
Horse power of engine	380	145
Gross tonnage (GRT)	115.8	42.0
Registered tonnage (NRT)	78.8	12.8
Crew complement	12	8
Chill tank capacity (t)	3.5	No freezing facility
Chill tank temperature (°C)	-2	-do-
Fish hold capacity (t)	25.0	7.5
Fish hold temperature (°C)	-18	-18
Type of net	Four seam shrimp trawl	Four seam shrimp trawl
Length of head rope of net (m)	26.25	21.54
Codend mesh size (mm)	30	25
Dimensions of otter boards (m)	3.0 x 1.2	1.8 x 0.8
Weight of otter boards (kg)	200	75
Trawling speed in knots	2.5	3.0

Both the types of vessels are provided with echo-sounder and radiotelephone. The large trawlers have freezing facility on board the vessels, while the mini trawlers do not have such a facility. They carry ice in the fish hold and store the catch in ice. The large rawlers could stay at sea for 18-23 days while the mini-trawlers can stay only for 8-10 days. Although they operate from Visakhapatnam, very often they take shelter in Paradeep Harbour whenever the sea is rough and not possible to conduct fishing. As the weather in the northern Bay of Bengal is highly unpredictable, the time spent by these vessels at Paradeep is quite considerable.

The vessels operate two identical nets simultaneously from the outriggers on both sides of the boat. Generally a haul lasts for about 3-4 hours, although hauls of upto 6 hours duration are quite common. Daily a boat conducts operations for about 15-20 hours if not hampered by bad weather and mechanical failures. All these boats conduct aimed trawling for penaeid prawns. However, a good quantity of fish are also caught. Most of the fish catch is composed of low quality species and hence is discarded immediately, retaining only quality fishes such as pomfrets, seers, eels, tunas, polynemids, catfishes and perches. The amount of by-catch discarded at sea varies from vessel to vessel and in the same vessel from haul to haul and season to season. None of the vessels keep any records of these discards and hence it is not possible to estimate the total catch of these trawlers.

The big trawlers generally operate between Pentakota (17°N lat.) in the south aad Sunderbans (21°N lat.) in the north including the vast areas of the Sandheads (Fig. 1). Although they fish over wider areas, most of the effort is expended between Gopalpur (19°N lat.) and the Sunderbans (21°N lat.). These vessels generally fish in the depth range of 40-80 m and rarely in 10-40 m and beyond 80 m depth ranges.

Retrieval and analysis of data from the fishing logs

Most of these trawlers maintain a regular fishing log. However, there is no uniformity in the fishing log of different vessels. For the sake of uniformity the data have been transformed to yield data on effort in sea days, fishing days, fishing hours and catch of total prawns and composition of 'tiger', 'white', 'brown' and 'others' in the landings. Any ambiguity observed in the fishing logs was got clarified by discussions with crew of the vessels. Some of the vessels could not provide fishing log. Hence, the data are extrapolated

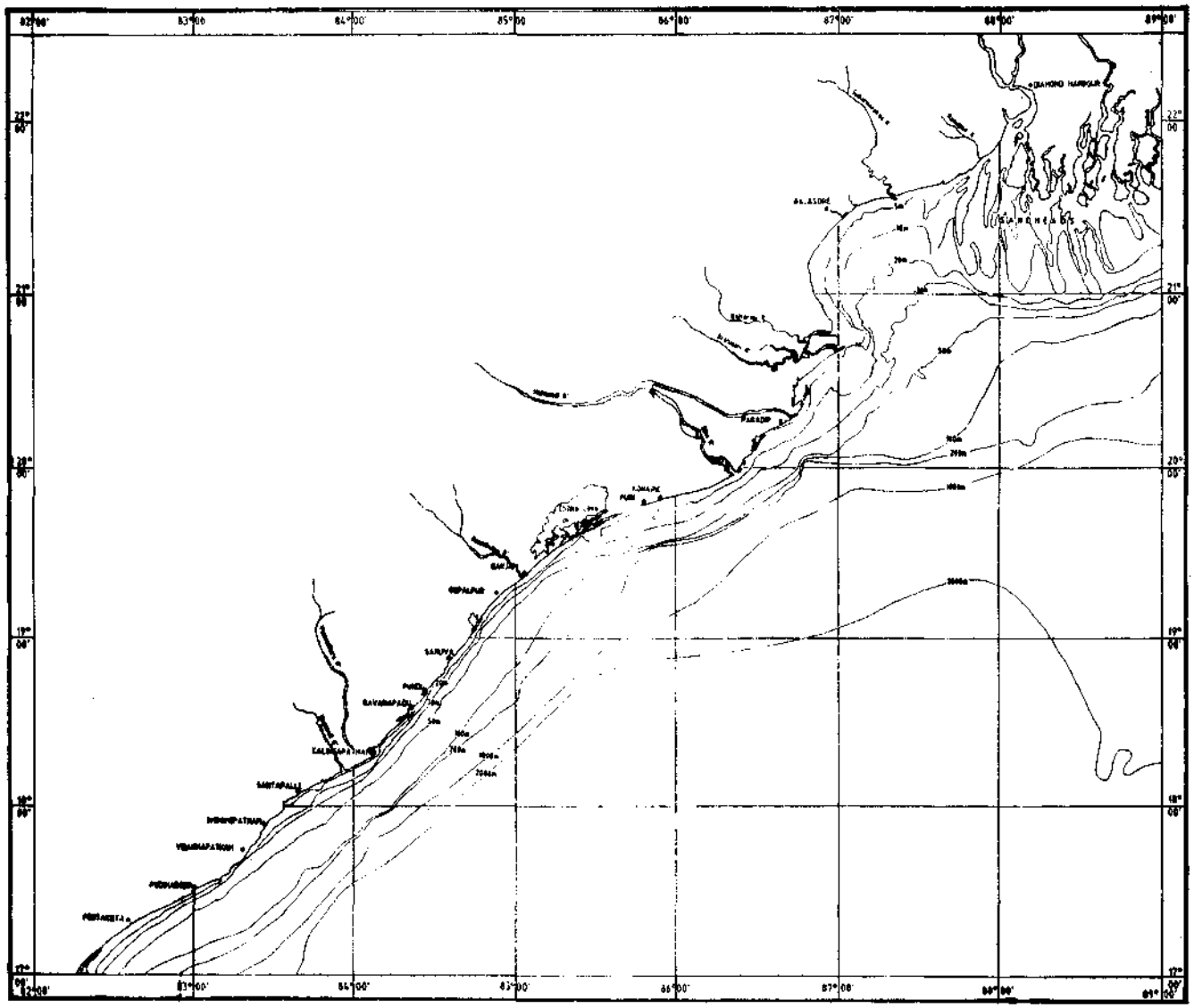


Fig. 1. Map showing the northeast coast of India with depth contours.

to the total number of vessels operated based on the data for which fishing logs were available. The accessibility to fishing logs of vessels in different years is as follows:

Years	Vessels for which fishing log was available	Total number of vessels operated
1983–'84	13	55
1984–'85	38	60
1985–'86	43	76
1986–'87	45	91 + 9

None of the mini trawlers could provide data. Observations at the landing centre indicated that the prawn landings of three mini trawlers were equal to one big trawler. Hence, 27 mini trawlers are standardised as 9 large trawlers in 1986–'87.

A species-wise breakup of the prawn catch was not possible since the catch is recorded as 'headless tiger', 'headless white', 'headless brown' and 'headless flower'. However, the species composition of different categories was found to be as follows:

'Tigers' : *Penaeus monodon, P. semisulcatus* and *P. japonicus*

'Whites' : *P. indicus, P. merguiensis* and *P. penicillatus*

'Browns' : *Metapenaeus monoceros, M. ensis* and *M. affinis*

'Flowers' : *M. brevicornis* and *M. dobsoni*

Fishing hour or trawling hour *i.e.*, the time actually spent in trawling was taken as a standard unit of effort than any other time unit such as sea day, fishing day and fishing haul and the catch obtained for one hour of trawling or catch per hour of trawling (CPH) was considered as an index of abundance. While analysing the data month-wise, the data of landing at Visakhapatnam was taken as the criterion to include the voyage in that month irrespective of the month of departure.

The fishery

Catch and effort

Monthly distribution of effort in terms of voyages, sea days, fishing days and fishing hours for the four-year period 1983–'84 to 1986–'87 is shown in figures 2–5. With the increase in the number of vessels in the fishing fleet from 55 in 1983–'84 to 100 in 1986–'87, the effort in respect of voyages, sea days, fishing days and fishing

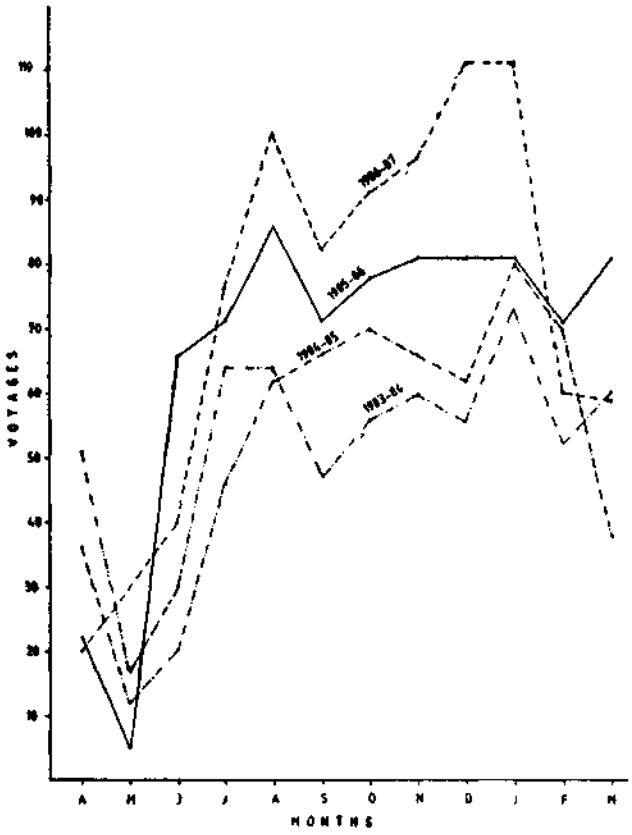


Fig. 2. Monthly effort of big trawlers during 1983–'84 to 1986–'87.

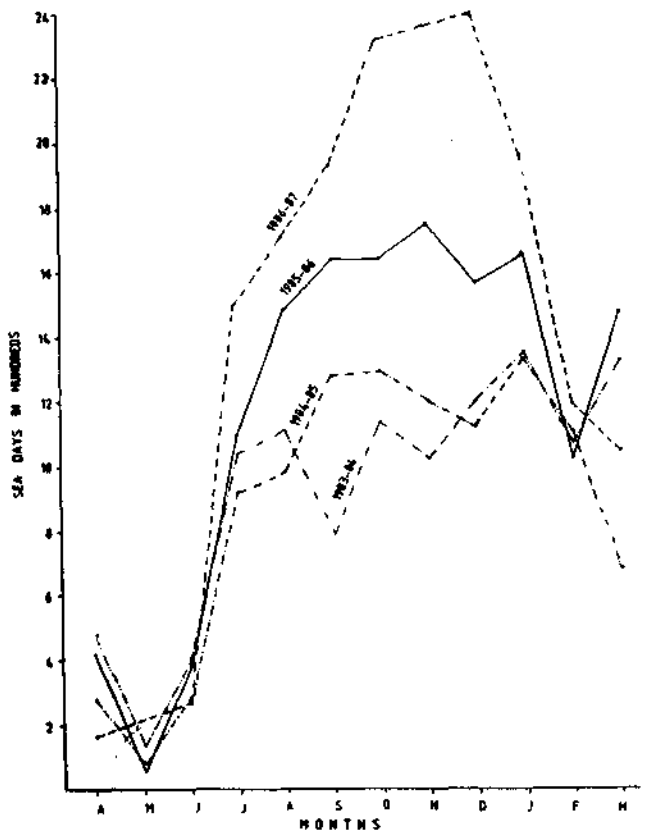


Fig 3. Monthly effort in sea days of big trawlers during 1983–'84 to 1986–'87.

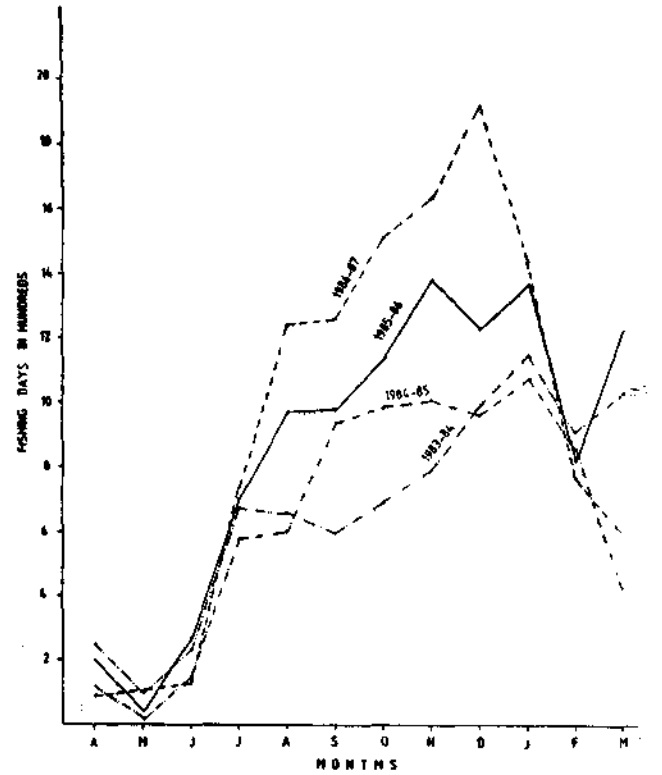


Fig. 4. Monthly effort in fishing days of big trawlers during 1983–'84 to 1986–'87.

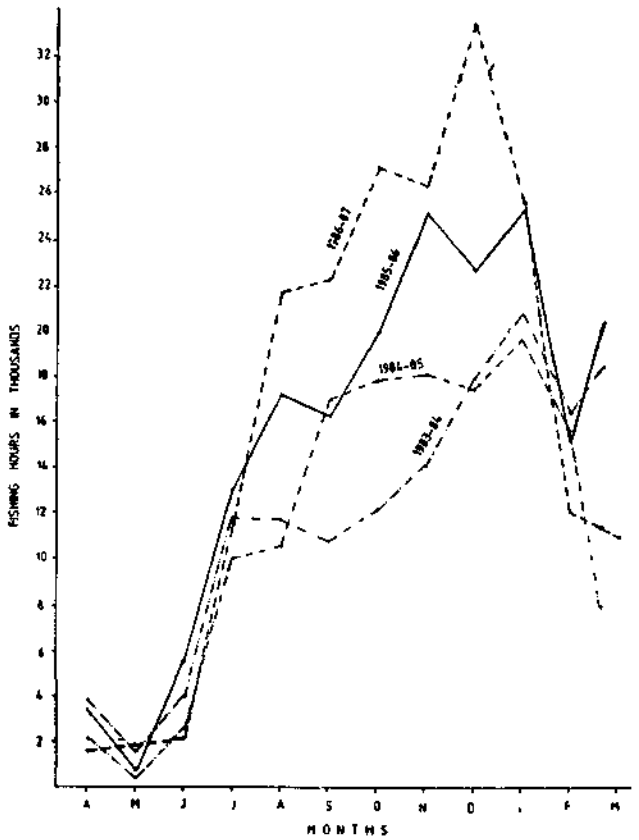


Fig. 5. Monthly effort in fishing hours of big trawlers during 1983–'84 to 1986–'87.

hours gradually increased during the period under study. Fishing effort is at a minimum during April - June, from when gradually increased to reach a peak during October - December and then declined gradually to March. This trend was followed in more or less all the four years for which data are available.

Data on monthly prawn landings and CPH for prawns for the four-year period are presented in figures 6 and 7 and the annual data on catch and effort is presented in Table 1. In 1983-'84 an estimated 2,353 t of prawns were landed by 55 vessels operated during that year. These vessels fished for about 143,961 trawling hours recording a CPH of 16.3 kg. Prawn landings varied from 10.8 t in May to 395.5 t in January while the CPH varied from 5.9 kg in April to 27.2 kg in October. Almost 55% of annual quantity was landed in October–January. The fishery realised Rs. 180.1 million (ex-vessel) during this year.

In 1984-'85, 60 vessels landed 2,815.5 t of prawns for an effort of 139,929 trawling hours with a CPH of 20.1 kg. Prawn landings gradually increased from 1.8 t in May to 431.2 t in September and then declined to 64.9 t in March while the CPH increased from 5.2 kg in May to 28.5 kg in November and then declined to 8.0 kg in March (Figure 7). The fishery realised Rs. 225.2 million during this year.

The annual prawn landings in 1985-'86 were estimated at 3,043.0 t for an effort of 184,874 trawling hours expended by 75 vessels. The increase in the landings was only 7% while the increase in effort was 24%. Prawn landings gradually increased from May (20.3 t) till November (471.0 t) and then declined gradually till May, whereas the CPH gradually increased from July (15.7 kg) to September (21.7 kg) and then declined gradually till February (9.2 kg) with the average estimated at 16.3 kg. During the year the landings were valued at Rs. 272.9 million, an increase of over 21% from that of the previous year.

In 1986–'87, 100 vessels (91+9) landed an estimated 3,077.5 t of catch for an effort of 195,300 trawling hours with an average CPH of 15.8 kg. Although the increase in effort was 5% the increase in catch was only 1%. Prawn landings gradually increased from June (45.8 t) till December (558.9 t) and then declined till March (84.2 t) while the CPH increased from 16.1 kg

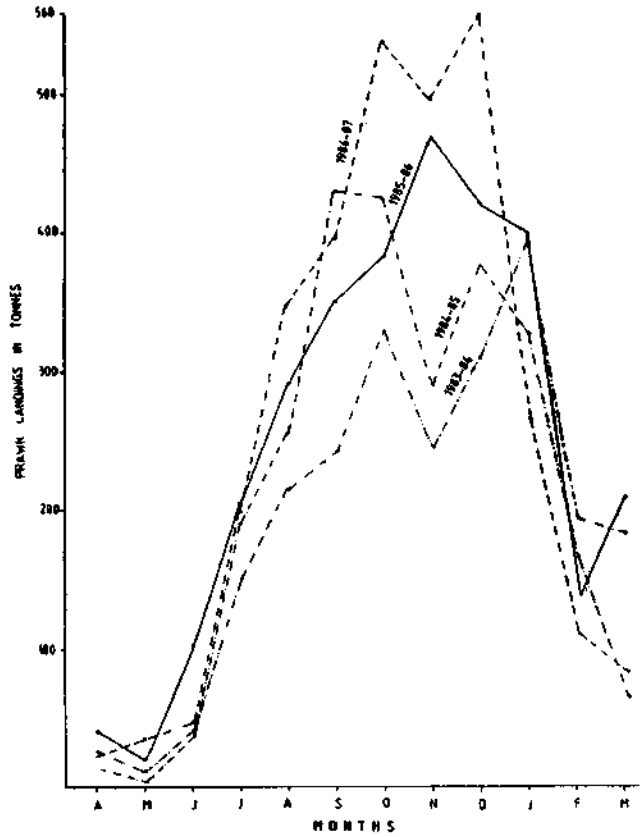


Fig. 6. Monthly prawn landings by big trawlers during 1983–'84 to 1986–'87.

in August to 19.8 kg in October and then declined gradually to 7.6 kg in March. The annual landings were valued at Rs. 375.1 million, an increase of over 27% over that of the previous year.

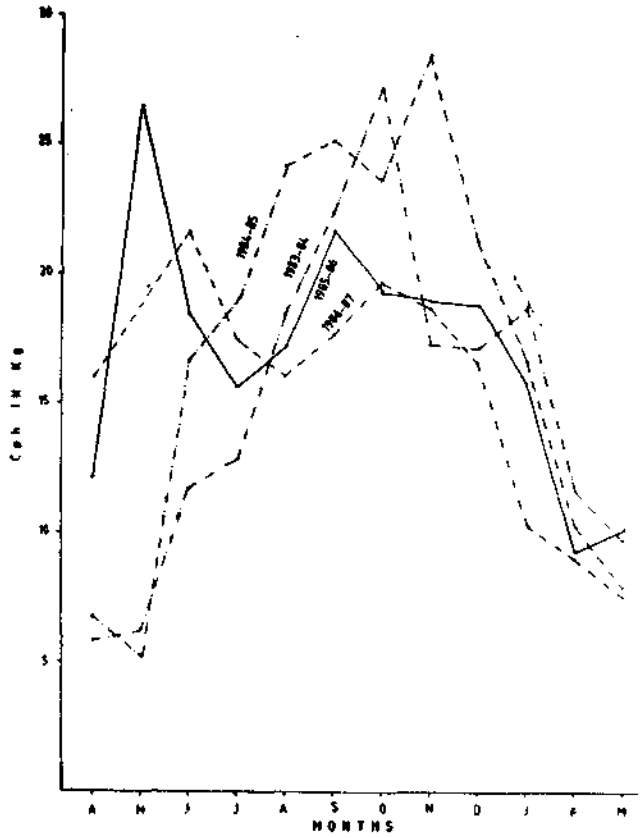


Fig. 7. Monthly CPH by big trawlers duriug 1983–'84 to 1986–'87.

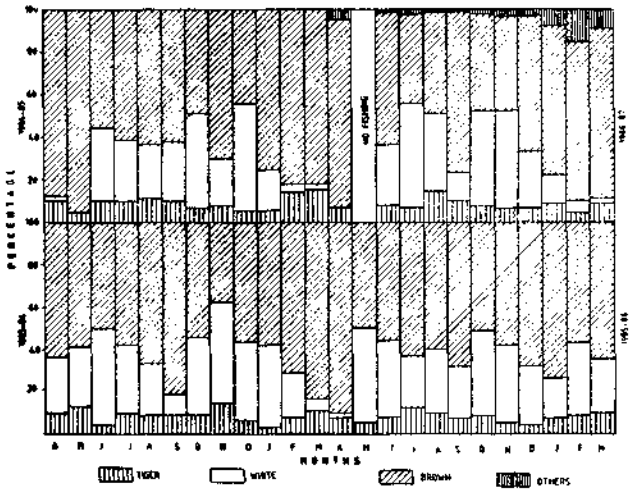


Fig. 8. Mon thly catch composition of prawn landings of big trawlers during 1983–'84 to 1986–'87.

Catch composition

The catch was composed of 'tigers' (8.1%), 'whites' (29.9%), 'browns' (60.7%) and 'others' (1.3%). The proportion of 'others' in the first three years was negligible. Monthwise percentage composition is presented in Fig. 8. It is observed that 'browns' dominated the catches in almost all the months followed by 'whites' and 'tigers'.

'Tigers': Monthly landings and CPH of 'tigers' during the four-year period are presented in Fig. 9. The landings of tigers in 1983–'84 were estimated at 194.3 t, forming about 8.3% of the annual prawn landings. The landings gradually increased from May (1.4 t) till November (34.3 t) and then decreased in December and January followed by an increasing trend till March (20.4 t). CPH also indicated more or less similar trend with the annual CPH estimated at 1.4 kg.

With an estimated catch of 236.5 t, 'tigers' formed about 8.4% of the prawn landings in 1984–'85 (Table 1). The landings exhibited peaks in September (43.8 t), November (37.7 t) and February (23.0 t) whereas peaks for CPH were observed in August (2.7 kg), November (2.1 kg) and February (1.5 kg). The annual average CPH was recorded at 1.7 kg against 1.4 kg of the previous year.

233.5 t of 'tigers', forming about 7.7% of the prawn landings, were landed in 1985–'86. The peaks in the landings were observed in August (30.4 t), October (33.7 t), January (32.6 t) and March (19.9 t). The CPH also followed the same trend. The average CPH was 1.3 kg, about 0.4 kg lesser than that of the previous year.

With an estimated catch of 255.4 t, 'tigers' formed about 8.3% of the prawn landings in 1986–'87 (Table 1). The landings exhibited peaks in August (48.8 t), October (41.9 t) and December (38.0 t) while the CPH gradually declined from August (2.3 kg) till February (0.4 kg). Annual CPH did not vary from 1.3 kg recorded in the previous year.

'Whites': Annual landings varied from 719.7 t in 1983–'84 to 954.4 t in 1986–'87 (Table 1) while the CPH varied from 4.8 kg in 1985–'86 to 5.8 kg in 1984–'85. Month-wise landings and CPH of 'whites' are presented in Fig. 10. During 1983–'84, the landings for 'whites' exhibited peaks in August (53.6 t), October (121.6 t) and January (154.0 t) whereas the peaks in CPH were in June (5.3 kg), October (10.0 kg) and January (7.4 kg).

Table 1. *Catch and effort of big trawlers operating from Visakhapatnam during the years* 1983–'84 *to* 1986–'87

Particulars		1983–'84	1984–'85	1985–'86	1986–'87
Vessels in operation		55	60	75	100
No. of voyages		630	628	794	847
No. of days at sea		11,051	10,518	14,175	16,843
No. of fishing days		8,071	7,746	10,306	11,344
No. of fishing hours		143,961	139,929	184,874	195,300
Prawn catch in t		2,353.0	2,815.5	3,043.0	3,077.5
CPH in kg		16.3	20.1	16.5	15.8
Catch composition					
'Tiger'	Catch in t	194.3	236.6	233.7	255.4
	CPH in kg	1.4	1.7	1.3	1.3
	%	8.3	8.4	7.7	8.3
'White'	Catch in t	719.7	812.6	889.4	954.4
	CPH in kg	5.0	5.8	4.8	4.9
	%	30.6	28.9	29.2	31.0
'Brown'	Catch in t	1,417.5	1,757.1	1,912.7	1,763.3
	CPH in kg	9.9	12.6	10.4	9.0
	%	60.2	62.4	62.9	57.3
Other prawns catch in t		21.5	9.4	7.2	104.4
Value in millions of Rs.		185.1	225.2	272.9	375.1

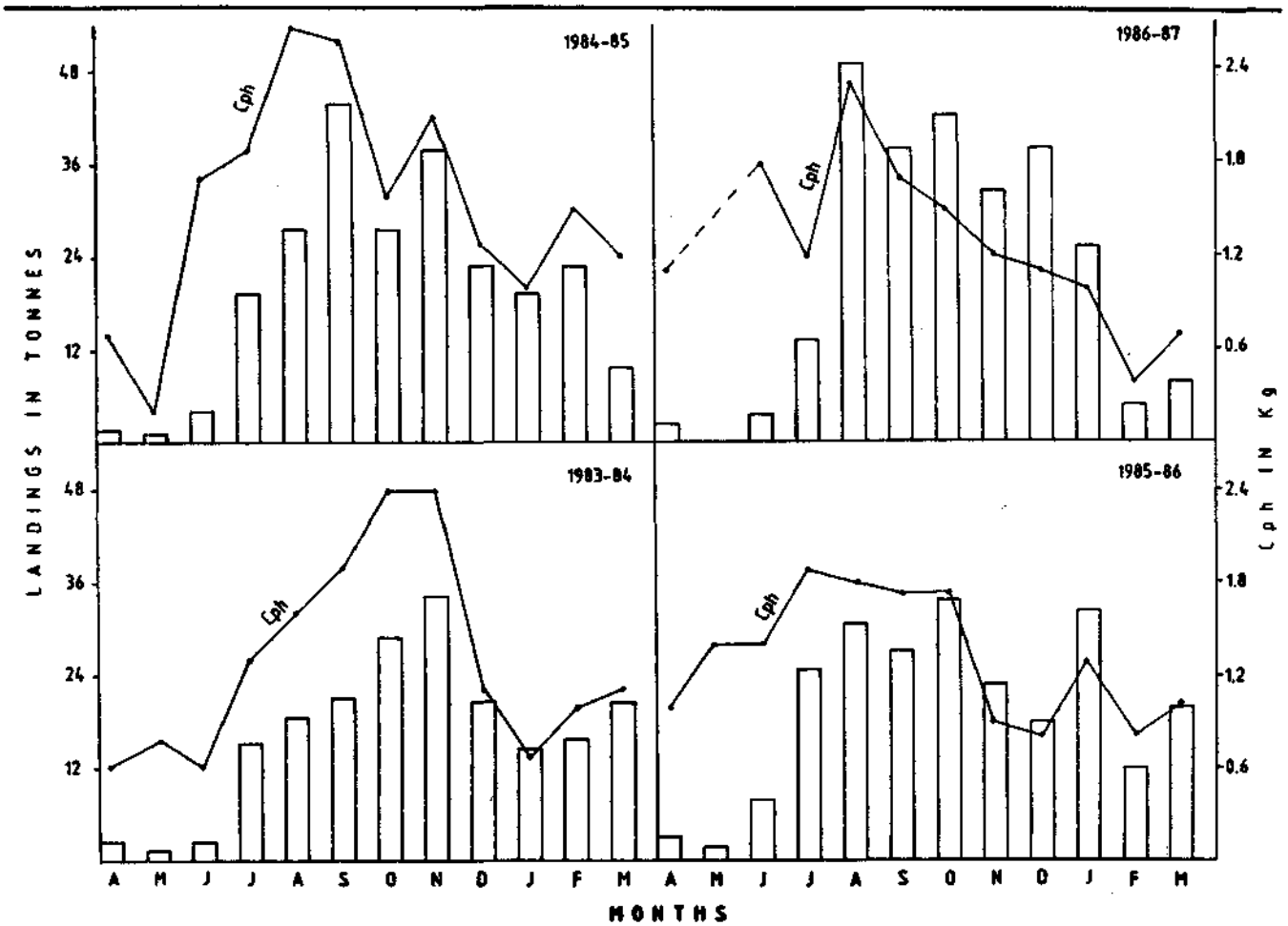


Fig. 9. Monthly catch and CPH of 'tigers' by big trawlers during 1983–'84 to 1986–'87.

Table 2. *Pooled monthly averages of catch and effort of big trawlers operating from Visakhapatnam (Pooled for the period April, 1983 to March, '87)*

Particulars		Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
No. of voyages		32	8	39	64	78	66	74	76	77	86	63	60	723
Days at sea		331	67	335	1,137	1,320	1,411	1,597	1,583	1,572	1,575	1,090	1,128	13,145
Fishing days		164	38	194	669	870	943	1,082	1,207	1,277	1,261	840	820	9,365
Fishing hrs.		2,709	704	3,527	11,564	15,267	16,608	19,303	20,924	22,932	2,2921	1,4985	14,572	166,016
Prawn catch in t		25.2	8.2	59.4	1,86.9	279.0	356.4	420.4	432.4	417.6	348.3	152.7	135.5	2,822.0
CPH in kg		9.3	11.6	16.8	16.2	18.3	21.5	21.8	20.7	18.2	15.2	10.2	9.3	17.0
Catch composition														
'Tiger'	Catch in t	1.8	0.6	4.6	18.1	31.3	32.5	33.0	31.8	24.8	22.8	13.4	14.4	229.1
	CPH in kg	0.7	0.9	1.3	1.6	2.1	2.0	1.7	1.5	1.1	1.0	0.9	1.0	1.4
	%	7.1	7.3	7.7	9.7	11.2	9.1	7.8	7.4	5.9	6.5	8.8	10.6	8.1
'White'	Catch in t	1.7	3.0	21.7	63.7	83.4	71.7	176.3	158.9	141.1	80.1	25.7	16.6	843.9
	CPH in kg	0.6	4.3	6.2	5.5	5.5	4.3	9.1	7.6	6.2	3.5	1.7	1.1	5.1
	%	6.7	36.6	36.5	34.1	29.9	20.1	41.9	36.7	33.8	23.0	16.8	12.3	29.9
'Brown'	Catch in t	21.1	4.5	33.0	103.6	163.4	250.0	205.8	236.7	245.3	238.3	108.5	102.4	1,712.6
	CPH in kg	7.8	6.4	9.3	9.0	10.7	15.1	10.7	11.3	10.7	10.4	7.2	7.0	10.3
	%	83.7	54.9	55.6	55.4	58.6	70.1	49.0	54.7	58.7	68.4	71.1	75.6	60.7
	Catch in t	0.6	0.1	0.1	1.5	0.9	2.2	5.3	5.0	6.4	7.1	5.1	2.1	36.4
	CPH in kg	0.2	0.1	0.0	0.1	0.0	0.1	0.3	0.3	0.2	0.3	0.4	0.2	0.2
	%	2.4	1.2	0.2	0.8	0.3	0.7	1.3	1.2	1.6	2.1	3.3	1.5	1.3

Whites formed about 30.6% of the prawn landings in 1983–'84.

With an estimated catch of 889.6 t, 'whites' formed about 29.2% of the prawn landings in 1985-'86. Although there was an increase in the catch, the CPH sharply declined as compared to the previous year. The landings gradually increased from April (0.8 t) and reached a peak in November (172.2 t) and then declined thereafter till March (53.3 t). The CPH gradually increased from 3.9 kg in July to 7.7 kg in October and then declined till March (2.6 kg).

The catch was estimated at 954.4 t forming about 31.0% of the prawn landings in 1986–'87. The landings increased from June (13.5 t) till October (239.1 t) and then declined gradually till March (2.2 t). The CPH showed random variations in June–September and declined from October (8.8 kg) till March (0.2 kg).

Pooled data for the four year period indicate that October–December was the best period for the fishery of 'whites' with better landings and CPH (Table 2). The landings gradually increased from April till October and then declined gradually till March.

'Browns': With an estimated catch of 1,417.4 t 'browns' formed 60.2% of the prawn landings in 1983–'84 (Table 1). The landings and CPH indicated peaks in September, January and March (Fig. 11). Annual average CPH was estimated as 9.9 kg with variations from 3.7 kg in April to 18.1 kg in September.

1757.1 t of 'browns' forming about 62.4% of the prawn landings, were caught in 1984–'85. Compared to the previous year, the increase in landings was about 20% while the average in CPH was about 22%. The landings and CPH exhibited peaks in September, November and January. CPH varied from 4.9 kg in May to 20.0 kg in November with the annual average estimated at 12.6 kg.

With an estimated catch of 1,912.8 t, 'browns' formed about 62.9% of the prawn landings in 1985–'86. The landings more or less gradually increased from 10.2 t in May to 294.7 t in January. The CPH varied between 5.2 kg in February to 14.6 kg in September with the annual average at 10.4 kg.

With an estimated landing of 1,763.3 t, 'browns' formed about 57.3% of the prawn landings in 1986–'87. The landings as well as CPH declined as compared to 1985–'86. The landings varied from 21.1 t in April to 356.1 t in December. The CPH varied from 6.0 kg in March to 13.4 kg in September with the average estimated at 9.0 kg. The CPH in April cannot be taken as an index since effort expended was negligible.

Pooled averages for the four-year period indicate that August – January was the best period for the fishery of 'browns' with about 78% of the catch landed during this period (Table 2). The CPH was also very high during the period as compared to the February – July period.

Distribution and abundance in different areas

Data of two vessels for 1985–'86 and 1986–'87 were analysed to study the abundance of prawns in space and time. During this period these vessels operated from Kalingapatnam (lat. 18°N-long. 84°E) to the Sunderbans (lat. 21°N and long. 89°E). Out of a total effort of 10,438 trawling hours, 32% was expended in Sandheads II (20°N and 88°E), 19% off Balasore and 14% off Chilka (Table 3). The CPH varied from 10.63 kg in Sandheads I to 14.84 kg off Sunderbans. The reason for not putting commensurate effort in areas off Kalingapatnam and off Gopalpur was mainly due to concentration of indigenous gear in these areas. Although the CPH recorded was high off anchorage and off Sunderbans the vessels could not expend more effort due to limited area available for trawling. In general it may be concluded that grounds off Kalingapatnam, Gopalpur, Chilka in the south and off Balasore, anchorage and Sandheads are more productive than the other grounds. Grounds off Chilka, Paradeep and in Sandheads I are better for 'tigers' while grounds off Gopalpur, Chilka and Balasore are better for 'whites'. 'Browns' are better represented in the grounds off Konarak, Sandheads II, off anchorage and Sunderbans than in the other areas.

Month-wise abundance of total prawns in different areas is presented in Table 4. Off Kalingapatnam (18°N and 84°E) the CPH varied from 1.96kg in February to 27.69 kg in September. The CPH varied from 4.44 kg in February to 15.26 kg in October off Gopalpur. It is observed that in many areas high CPH was recorded during August - December period and moderate values in June - July and poor values in February – May.

Month-wise abundance of 'tigers' in different areas is presented in Table 5. The abundance of tigers was more in the grounds off Balasore in July; off Kalingapatnam, in Sandheads II and off Anchorage in August and off Gopalpur, of Chilka lake, off Konarak and off

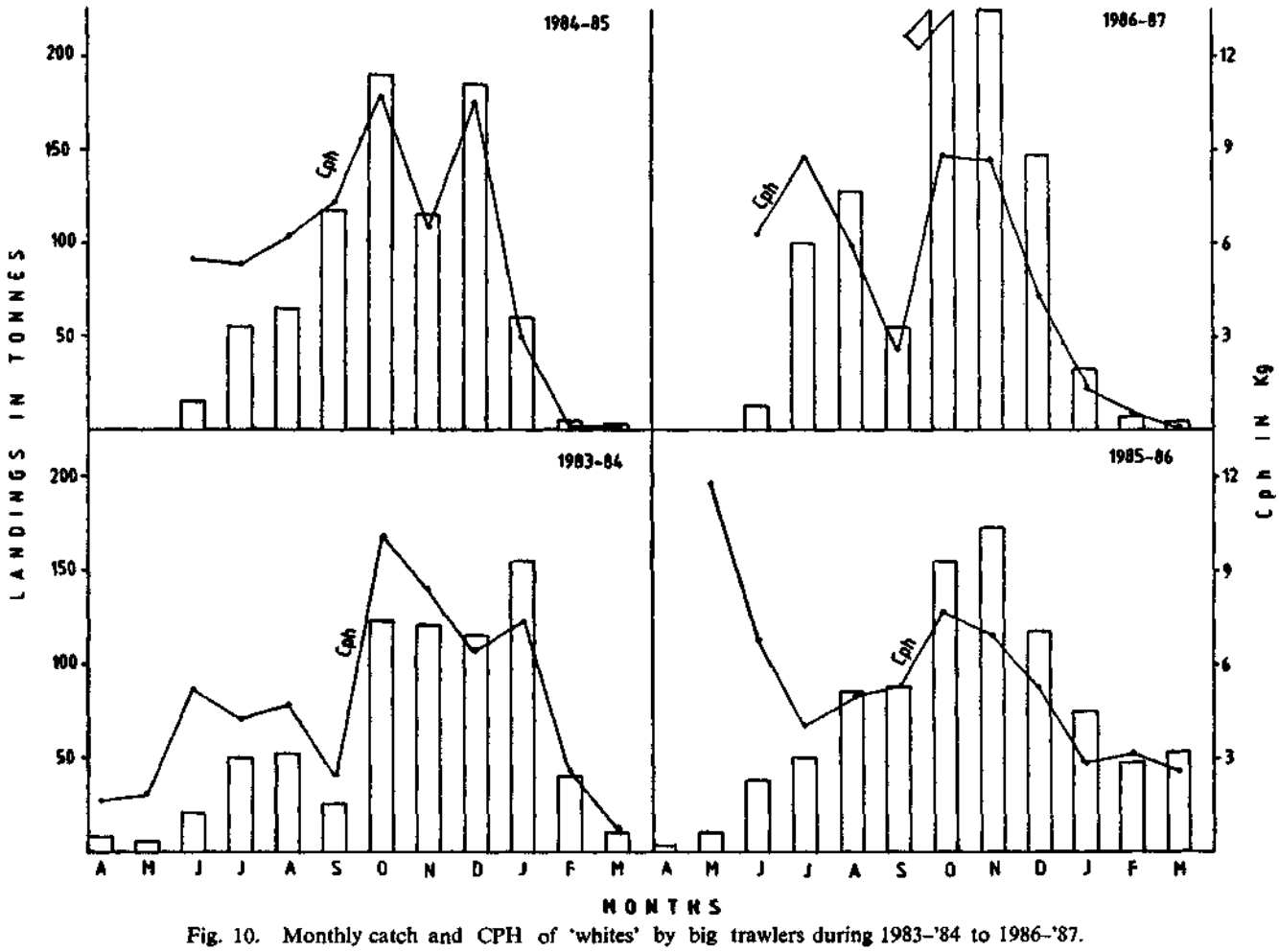


Fig. 10. Monthly catch and CPH of 'whites' by big trawlers during 1983–'84 to 1986–'87.

Table 3. *Abundance of prawns in different areas of northeast coast of India*

Area		Off Kalin-gapatnam	Off Gopal-pur	Off Chilka	Off Konarak	Off Para-deep	Sand heads I	Sand heads II	Off Bala-sore	Off Anch-orage	Off Sun-darbans
Latitude °N-Longitude °E		18–84	19–84	19–85	19–86	20–86	20–87	20–88	21–87	21–88	21–89
No. of hauls		38	40	363	67	76	285	772	486	269	84
Trawling time in hrs		146.5	153.3	1,485.3	292.3	325.3	1,159.3	3,308.5	1,934.3	1,188.0	445.8
Prawn catch in kg		1,865	2,012	18,759	3,515	3,531	12,320	39,653	24,280	15,024	6,613
CPH in kg		12.73	13.12	12.63	12.03	10.86	10.63	11.99	12.55	12.65	14.84
Catch composition											
'Tiger'	Catch in kg	116	141	2,248	305	528	1,913	2,104	1,518	679	91
	CPH in kg	0.79	0.92	1.51	1.04	1.62	1.65	0.64	0.78	0.57	0.20
'White'	Catch in kg	656	1,262	6,981	518	1,173	4,348	9,816	11,645	1,966	1,194
	CPH in kg	4.48	8.23	4.70	1.77	3.61	3.75	2.97	6.02	1.65	2.68
'Brown'	Catch in kg	1,093	609	9,550	2,692	1,830	6,059	27,733	11,117	12,379	5,328
	CPH in kg	7.46	3.97	6.43	9.21	5.63	5.23	8.38	5.74	10.42	11.96

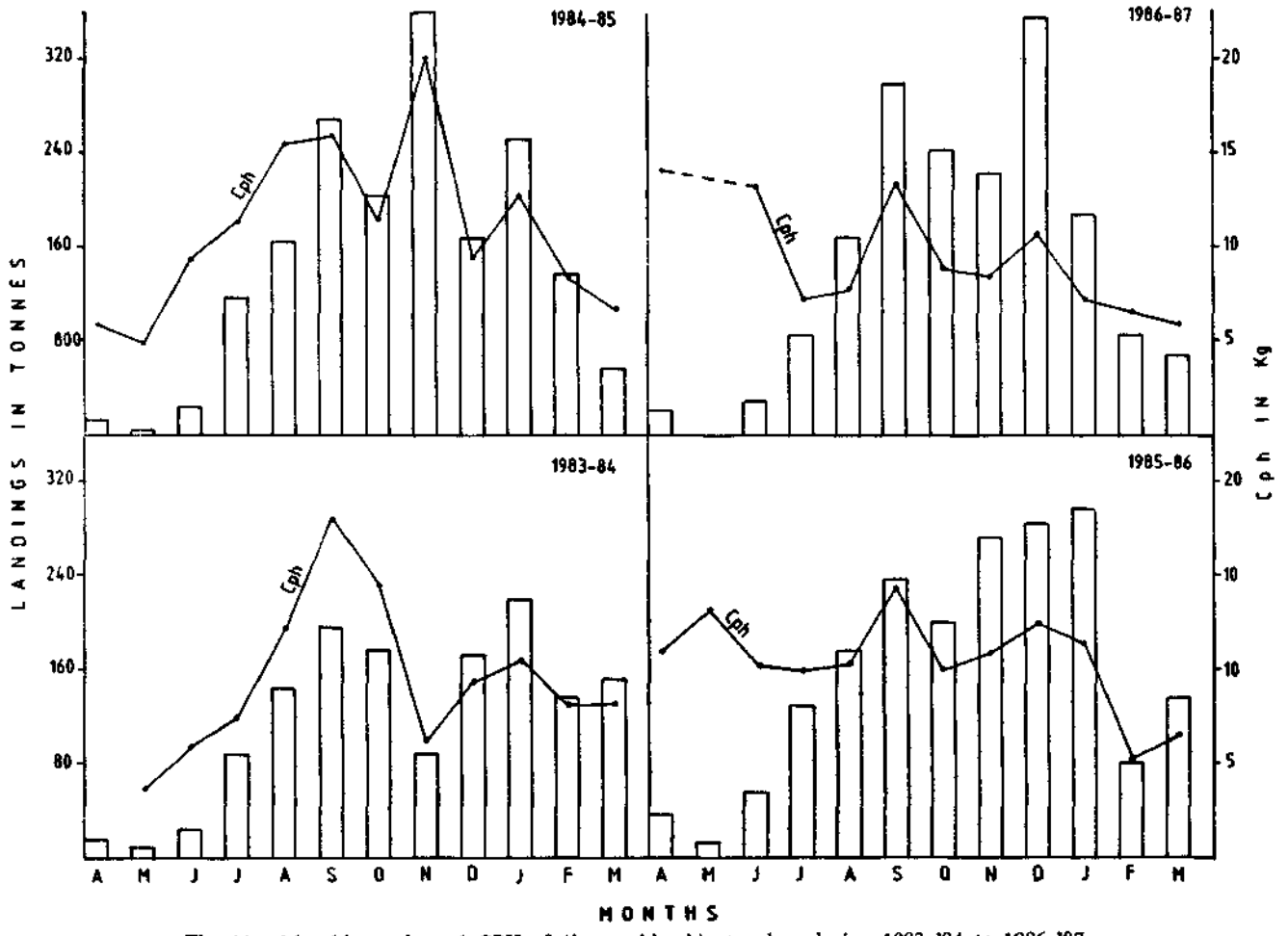


Fig. 11. Monthly catch and CPH of 'browns' by big trawlers during 1983–'84 to 1986–'87.

Table 4. *Month-wise abundance of prawns (CPH in kg) in different areas of northeast coast of India*

Latitude °N–Longitude °E	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
18–84	—	—	12.57	14.88	11.72	27.69	—	5.64	—	—	1.96	—	12.73
19–84	—	—	14.49	11.33	14.37	—	15.26	—	—	—	4.44	6.25	13.12
19–85	2.50	16.51	16.22	13.51	10.47	8.08	11.12	9.84	15.45	3.00	2.74	11.03	12.63
19–86	—	—	—	7.80	16.41	6.00	18.93	—	—	6.85	5.08	—	12.03
20–86	6.37	19.12	—	10.39	13.48	12.75	6.43	—	—	10.79	2.46	6.10	10.86
20–87	—	—	—	8.87	15.91	10.79	11.65	10.96	8.76	7.15	7.33	6.07	10.63
20–88	—	—	—	13.37	11.53	18.39	12.88	13.43	12.85	10.57	8.54	7.96	11.99
21–87	6.87	12.55	—	15.24	13.29	20.60	18.85	14.60	10.47	11.20	7.78	7.94	12.55
21–88	—	—	—	5.00	17.94	16.77	15.03	9.82	9.72	7.50	8.07	6.55	12.65
21–89	—	—	—	—	—	—	—	14.63	15.15	14.56	—	—	14.84

Table 5. *Month-wise abundance of 'tigers' (CPH in kg) in different areas of northeast coast of India*

Latitude °N-Longitude °E	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
18–84	—	—	0.26	0.35	1.79	1.54	—	0.36	—	—	0.17	—	0.79
19–84	—	—	0.90	NC	0.74	—	2.21	—	—	—	1.11	1.25	0.92
19–85	NC	0.75	1.11	1.46	1.98	3.04	5.04	1.30	0.55	NC	0.07	0.50	1.51
19–86	—	—	—	0.35	0.50	NC	2.52	—	—	1.12	0.34	—	1.04
20–86	0.44	1.12	—	1.53	1.42	1.40	3.14	—	—	0.10	0.31	1.08	1.62
20–87	—	—	—	1.09	2.17	1.60	0.55	2.14	0.78	2.73	1.83	1.14	1.65
20–88	—	—	—	1.59	1.76	0.56	0.93	0.62	0.93	0.31	0.11	0.28	0.64
21–87	0.30	1.39	—	2.38	1.81	2.56	0.57	0.22	0.77	1.20	0.42	0.03	0.78
21–88	—	—	—	NC	1.70	0.40	1.10	0.87	NC	0.19	NC	NC	0.57
21–89	—	—	—	—	—	—	—	0.53	0.07	0.19	—	—	0.20

NC = No Catch

Table 6. *Month-wise abundance of 'whites' (CPH in kg) in different areas of northeast coast of India*

Latitude °N-Longitude °E	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
18–84	—	—	4.23	2.08	7.81	12.31	—	3.64	—	—	NC	—	4.48
19–84	—	—	0.12	9.46	8.78	—	12.42	—	—	—	NC	NC	8.23
19–85	NC	10.52	5.25	4.29	4.94	3.60	1.71	0.17	NC	NC	0.02	NC	4.90
19–86	—	—	—	4.39	1.89	NC	0.25	—	—	NC	NC	—	1.77
20–86	NC	10.00	—	1.08	8.14	7.67	NC	—	—	0.10	NC	NC	3.61
20–87	—	—	—	0.11	6.71	2.02	1.39	7.38	6.93	0.07	2.49	1.67	3.75
20–88	—	—	—	3.21	0.53	3.15	6.69	5.22	2.18	1.86	1.13	2.23	2.97
21–87	NC	NC	NC	1.11	5.12	9.40	12.99	9.09	6.37	2.42	4.02	4.67	6.02
21–88	—	—	—	2.50	3.16	0.69	5.10	2.91	—	0.43	0.16	—	1.65
21–89	—	—	—	—	—	—	—	3.24	4.26	0.29	—	—	2.68

NC = No Catch

Table 7. *Month-wise abundance of 'browns' (CPH in kg) in different areas of northeast coast of India*

Latitude °N-Longitude °E	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
18–84	—	—	8.08	12.45	2.12	13.85	—	1.64	—	—	1.79	—	7.46
19–84	—	—	13.47	1.86	3.85	—	0.63	—	—	—	3.33	5.00	3.97
19–85	2.50	5.24	9.86	7.75	3.55	1.44	4.78	8.37	14.90	3.00	2.65	10.53	6.43
19–86	—	—	—	3.06	14.02	6.00	16.16	—	—	5.74	4.75	—	9.21
20–86	5.93	8.00	—	7.78	3.92	3.69	3.29	—	—	7.52	2.15	5.02	5.63
20–87	—	—	—	7.67	7.03	7.17	9.71	1.45	1.04	4.35	3.01	3.25	5.23
20–88	—	—	—	8.57	9.24	14.67	5.27	7.59	9.74	8.40	7.30	5.45	8.38
21–87	6.57	11.16	—	11.75	6.35	8.64	5.29	5.29	3.33	7.58	3.34	3.24	5.74
21–88	—	—	—	2.50	13.09	15.69	8.83	6.04	9.72	6.88	7.91	6.55	10.42
21–89	—	—	—	—	—	—	—	10.91	10.82	14.10	—	—	11.96

Table 8. *Depth-wise distribution of prawn catches of big trawlers during* 1985–'86 *and* 1986–'87 *(Data for* 6 *vessels pooled)*

Depth in metres		11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	91–100
No. of hauls		66	790	1,463	1,362	723	489	431	287	64
Trawling time in hours		201.5	2,820.3	5,549.5	5,714.8	3,280.0	2,226.5	1,883.8	1,286.8	300.5
Prawn catch in kg		3,192	30,527	72,652	59,000	34,971	26,971	25,461	19,036	4,917
CPH in kg		15.46	10.83	13.09	10.32	10.66	12.06	13.51	14.79	16.36
Catch composition										
'Tiger'	Catch in kg	50	1,460	4,149	7,213	5,408	1,972	1,343	822	193
	CPH in kg	0.25	0.52	0.75	1.26	1.65	0.88	0.71	0.64	0.64
	%	1.57	4.78	5.71	12.23	15.46	7.31	5.27	4.31	3.93
'White'	Catch in kg	2,862	20,638	48,623	19,668	6,766	4,544	2,337	707	114
	CPH in kg	14.20	7.32	8.76	3.44	2.06	2.03	1.24	0.55	0.38
	%	89.66	67.61	66.93	33.34	19.35	16.84	9.18	3.71	2.32
'Brown'	Catch in kg	280	8,429	19,880	32,119	22,797	20,455	21,781	17,507	4,610
	CPH in kg	1.39	2.99	3.58	5.62	6.95	9.15	11.56	13.60	15.34
	%	8.77	27.61	27.36	54.44	65.19	75.84	85.55	91.97	93.76

Table 9. *Month-wise abundance of prawns (CPH in kg) in different depth zones of northeast coast of India*

Depth in metres/months	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	91–100
January	—	8.25	6.51	6.54	9.93	10.79	12.53	18.54	—
February	10.79	7.45	6.39	6.94	6.29	9.30	8.06	6.54	—
March	7.50	8.03	6.62	7.53	6.78	7.72	—	—	—
April	—	—	3.33	10.21	—	—	—	—	—
May	—	—	27.97	18.06	15.06	—	—	—	—
June	—	5.63	17.15	14.91	15.42	—	—	—	—
July	—	9.56	13.18	12.08	14.98	7.61	14.00	12.17	—
August	—	10.42	13.30	9.87	9.58	17.47	20.07	14.38	15.23
September	—	12.22	15.03	14.40	13.85	11.85	15.54	18.10	19.34
October	8.00	14.91	17.44	12.43	10.84	11.40	11.27	15.04	21.43
November	22.64	12.94	13.34	9.41	14.95	11.65	14.22	15.10	14.89
December	13.71	11.14	10.94	9.70	11.01	12.48	13.53	14.55	16.67
All Months	15.46	10.83	13.09	10.32	10.66	12.06	13.51	14.79	16.36

— = No operation

Paradeep in October. Generally the abundance was less in most of the areas during the March-June period.

Month-wise abundance of 'whites' in different areas as indicated by CPH is presented in Table 5. The abundance was more off Kalingapatnam and off Paradeep in August and September while it was more off Gopalpur, Sandheads II, off Balasore and off Anchorage in October; off Sandheads I and off Sunderbans in November and December. CPH was poor in most of the areas during January - June period.

Month-wise abundance of 'browns' as indicated by CPH in different areas is given in Table 7. 'Browns' were abundant in July and September off Kalingapatnam; in June off Gopalpur; in June, December and March

off Chilka lake; in August and October off Konarak; in July and January off Paradeep; in July - October in Sandheads I; in July - February in Sandheads II; in July, September and January off Balasore; in August-March off Anchorage and in November - January off Sunderbans.

Abundance of prawns in relation to depth

To study the depth-wise abundance of prawns, data of six vessels from April, 1985 to March, 1987 were analysed. Depth zones were classified as 11-20 m, 21-30 m, 31-40 m *etc.*, to get a clear picture of abundance of prawns based on the CPH obtained in different zones.

Of the 5,675 hours expended by these vessels during the two year period, 50% of the effort was expended in 31-50 m depth range (Table 8). The depths of 21-30 m and 51-80 m were moderately fished and those of 11-20 m and 81-100 m were poorly fished. They never fished beyond 100 m depth.

The abundance randomly fluctuated in 11-40 m depth zone between 10.83 and 15.46 kg while it gradually increased from 41-50 m (10.32 kg) to 91-100 m (16.36 kg). The abundance of 'tigers' as indicated by CPH gradually increased from 11-60 m and then gradually declined beyond this depth. The proportion of 'tigers' in the total prawn catches also indicated a similar trend. The abundance of 'whites' was better in 11-40 m depth and then declined gradually beyond this zone. The proportion of whites gradually declined from 11-20 m (89.66%) to 91-100 m (2.32%). The abundance of 'browns' gradually increased from 11-20 m (1.39 kg) to 91-100 m (15.3 kg). Similarly the proportion of 'browns' in the prawn catches also increased gradually from 11-20 m (8.77%) to 91-100 m (93.76%).

Month-wise abundance of total prawns in different depth zones is presented in Table 9. The abundance of prawn was more in November and December in 11-20 m depth range, September - December in 21-30 m, May - November in 31-40 m, May - October in 41-50 m, May - November in 51-60 m, August — December in 61-70 m, July - January in 71-80 m, August - January in 81-90 m and August - December in 91-100 m depth ranges. In general the abundance was less in February-April in all the depths.

Month-wise abundance of 'tigers' in different depth zones is presented in Table 10. The abundance of tigers was more in October in 11-20 m, August-September in 21-30 m, May-October in 31-40 m, July - March in 41-50 m, May-August and December - February in 51-60 m, January, August and October in 61-70 m, and July - December in 71-80 m depth ranges. In 81-90 m and 91-100 m it was negligible in the catches.

Month-wise abundance of 'browns' in different, depth zones is presented in Table 12. The abundance

Table 10. *Month-wise abundance of 'tigers' (CPH in kg) in different depth zones of northeast coast of India*

Depth in metres/months	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
January	—	NC	0.14	0.99	2.57	1.48	0.20	0.63	—
February	NC	0.64	0.11	1.27	1.18	0.04	0.24	0.08	—
March	—	0.17	0.44	1.53	0.25	0.12	—	—	—
April	—	—	0.14	0.52	—	—	—	—	—
May	—	—	0.92	0.71	1.37	—	—	—	—
June	—	0.31	1.19	0.98	1.60	—	—	—	—
July	—	0.10	0.40	1.11	1.95	0.87	1.43	0.37	—
August	—	1.47	1.39	2.50	1.72	1.09	1.49	0.63	1.82
September	—	1.32	1.37	1.21	0.38	0.34	0.52	0.37	NC
October	1.33	0.38	1.12	1.02	1.59	1.35	1.44	1.24	NC
November	0.26	0.54	0.63	0.67	0.77	0.72	0.59	0.84	0.53
December	0.16	0.08	0.17	1.13	1.52	0.91	1.42	0.31	0.25
All Months	0.25	0.52	0.75	1.26	1.65	0.88	0.71	0.64	0.64

— = No operation NC = No catch

Table 11. *Month-wise abundance of 'whites' (CPH in kg) in different depth zones of northeast coast of India*

Depth in metres/months	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	91–100
January	—	7.06	2.35	0.23	0.12	0.01	0.03	0.62	—
February	10.35	5.22	3.16	0.39	0.05	0.92	0.12	NC	—
March	4.50	5.89	1.81	0.04	NC	NC	—	—	—
April	—	—	NC	NC	—	—	—	—	—
May	—	—	14.04	6.85	NC	—	—	—	—
June	—	2.19	4.90	4.78	4.72	—	—	—	—
July	—	5.39	9.42	3.56	2.14	NC	3.52	NC	—
August	—	3.33	9.09	3.93	3.47	2.88	2.33	NC	NC
September	—	5.88	8.21	7.79	6.17	1.43	1.13	0.05	NC
October	6.00	8.71	13.22	7.46	2.08	3.26	2.12	0.82	NC
November	21.35	10.78	9.67	4.82	9.39	3.71	2.39	0.69	0.96
December	11.45	9.41	8.60	3.43	2.00	2.76	1.59	0.73	NC
All Months	14.20	7.32	8.76	3.44	2.06	2.03	1.24	0.55	0.38

— = No operation NC = No catch

Table 12. *Month-wise abundance of 'browns' (CPH in kg) in different depth zones of northeast coast of India*

Depth in metres/months	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	91–100
January	—	1.19	4.02	5.31	7.24	9.30	12.30	17.29	—
February	0.44	1.59	3.12	5.28	5.06	8.34	7.70	6.46	—
March	2.50	1.97	4.37	5.96	6.53	7.60	—	—	—
April	—	—	3.19	9.69	—	—	—	—	—
May	—	—	13.01	10.50	13.69	—	—	—	—
June	—	3.13	11.06	9.15	9.10	—	—	—	—
July	—	4.07	3.36	7.41	10.89	6.74	9.05	11.80	—
August	—	5.62	2.82	3.44	4.39	13.50	16.25	13.75	13.41
September	—	5.02	5.45	5.40	7.30	10.07	13.89	17.68	19.34
October	0.67	5.82	3.10	3.95	7.17	6.79	7.71	12.98	21.43
November	1.03	1.62	3.04	3.92	4.79	7.22	11.24	13.57	13.40
December	2.10	1.65	2.17	5.14	7.49	8.81	10.52	13.51	16.42
All Months	1.39	2.99	3.58	5.62	6.95	9.15	11.56	13.60	15.34

— = No operation

of 'browns' was more in August–October in 21–30 m, May–June in 31–40 m, April–July in 41–50 m and May–July in 51–60 m depth ranges. In the depth range of 21–60 m 'browns' were abundant in almost all the months.

General Remarks

The present analysis of the four year data (1983–'84 to 1986–'87) shows that the number of vessels in the fleet increased from 55 in 1983–'84 to 100 in 1986–'87. The effort expended also increased from 143,961 trawling hours in 1983–'84 to 195,300 hours in 1986–'87. Although the landings also increased over the years it is not commensurate with the effort. Catch per hour of trawling (CPH) for total prawns declined gradually from 20.1 kg in 1984–'85 to 15.8 kg in 1986–'87. CPH for 'browns', the dominant component of the prawn landings, also declined from 12.6 kg in 1984–'85 to 9.0 kg in 1986–'87 (see Table 1). The other two groups of prawns, 'tigers' and 'whites', also indicated a decline in CPH over the years. This clearly shows that the

fishery has already reached a peak in 1984–'85 and is on a downward trend.

Rao *(Indian J. Fish.,* **34** (4) : 312 – 328*)* estimated the potential resource of prawns between Pentakota and the Sunderbans as 6,577 t and suggested that the stock can withstand the fishing pressure of 104 big trawlers apart from the existing small mechanised boats and indigenous craft. In1986–'87 about 100 big trawlers fished in these waters. Even at this level of effort the CPH has gone down considerably, and it may go down further in 1987–'88 as the number of vessels is likely to increase to 125. It is evident from the available results on catch and effort and potential estimate that the fishery is at the threshold of over fishing, and the time has come to think about the conservation of the resource.

Gulland (In *Penaeid Shrimps - their biology and management,* Fishing News Books Limited, 290–298, 1984) discussed the merits and demerits of the conservation methods applicable to prawn fisheries. The methods in order of priority are:

i) Restriction on number of fishing vessels,
ii) imposition of closed season,
iii) regulation of mesh size and
iv) catch quotas.

In the present instance, the industry came forward to impose a ban on fishing for two months, during April 15 to June 15, in 1985–'86 fishing season. However, this self imposed ban did not yield expected results in the ensuing 1986–'87 season as the CPH came down further. The operators observed a closed season for three months, during April 1 to June 30, in 1986–'87 season, although reluctantly. This also is not showing any increasing trend in the catch rate in the current season (1987–'88). So the closed season has not proved to be effective in increasing the catch rates.

Presently most of the trawlers are using nets with codend mesh size of 30 mm. There is no need to increase the mesh size any further.

Another alternative is to fix a catch quota for these boats. This has been attempted in many countries and found it to be a complicated procedure to implement, as this leads to over capitalisation if there is no restriction on the number of vessels owned by a single individual or firm.

Finally, we are left with one alternative namely, restriction of the number of vessels operating on the fishery. If we fail to exercise this restriction, there may be a crisis not only in respect of big trawlers but also for small mechanised boats since both the fleets share the same resource.

SUCCESSFUL INDUCED SPAWNING AND REARING OF THE HOLOTHURIAN *HOLOTHURIA (METRIATYLA) SCABRA* JAEGER AT TUTICORIN*

In India holothurians are exploited exclusively for export purpose. From holothurians a product commercially known as *beche-de-mer* is prepared. India at present is earning a foreign exchange equal to Rs. 20 lakhs per annum. Presently the markets in Hong Kong and Singapore offer US $ 20 per kg of *beche-de-mer*. Although the price offered by the importers is very attractive and the process involved in the preparation of the product is very simple and inexpensive, the major constraint for the development of the industry is the shortage of raw materials. On the mainland of India the holothurians are restricted to the Gulf of Mannar and Palk Bay region. At present two species of holothurians viz., *Holothuria (Metriatyla) scabra* and *Holothuria (Theelothuria) spinifera* are exploited commercially and there are evidences of over exploitation of these species. This situation forced the Government of India to impose a ban in 1982 on the export of the processed holothurians of less than 8 cm in size

* Prepared by D. B. James, M. E. Rajapandian, B. K. Baskar and C. P. Gopinathan, Tuticorin Research Centre of CMFRI, Tuticorin.

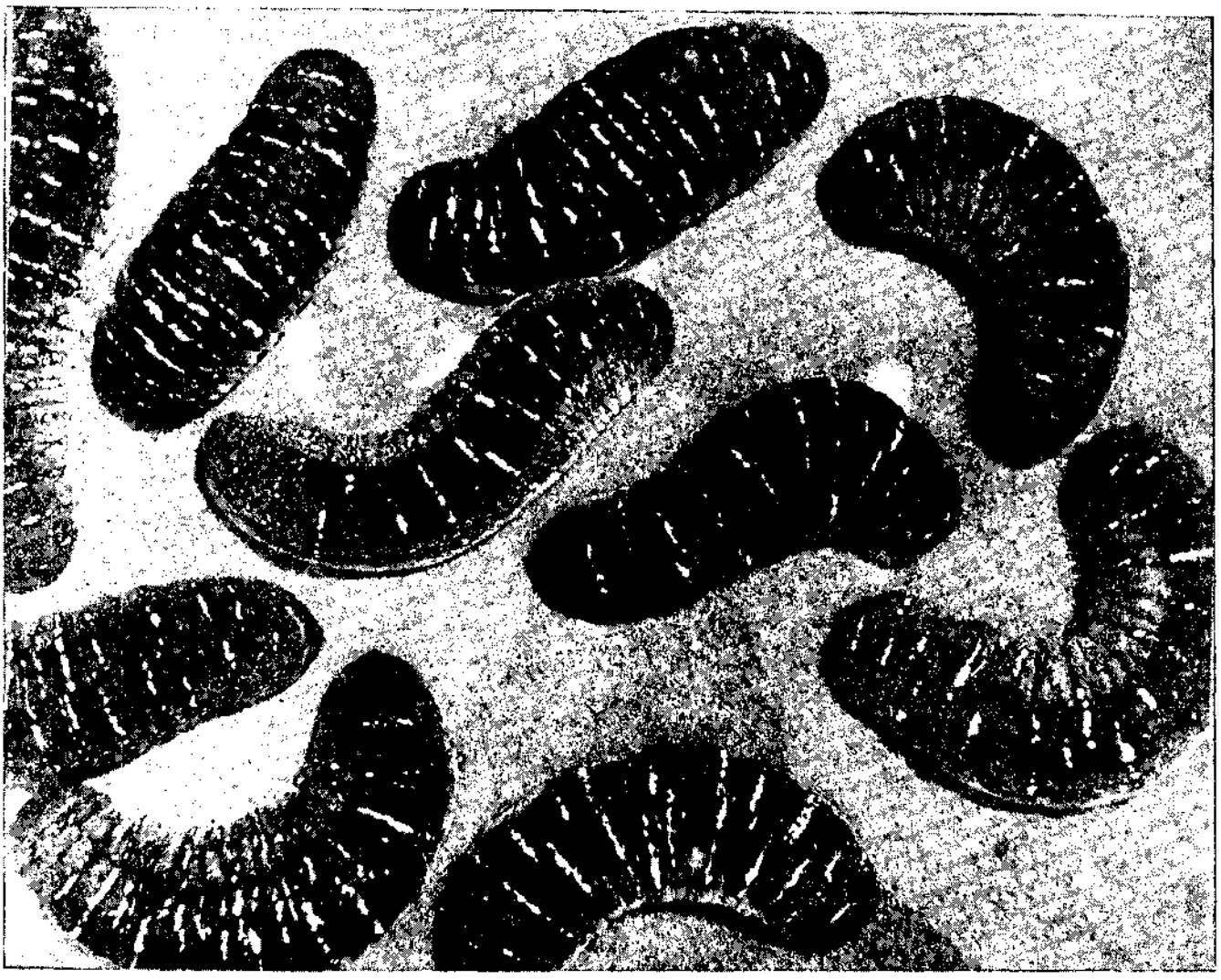


Fig. 1. A group of adult *Holothuria (Metriatyla) scabra.* (*Photo:* Mr. M. Kathirvel)

as a measure of conservation. As a result of this ban the *beche-de-mer* industry is facing a crisis in this country.

At this juncture the Central Marine Fisheries Research Institute, ventured upon a programme on the artificial breeding and production of seed for culture and propagation of the commercially valuable holothurian species. The Institute's success on the above aspects under controlled conditions is significant which may eventually solve the problems presently faced by the *beche-de-mer* industry in India. This is the first time that such work is carried out in India.

Large specimens of *Holothuria (Metriatyla) scabra* (300-350 mm/ 500-600 g) were brought to the laboratory in the last week of January, '88 and they were acclimatised to the laboratory conditions (Fig. 1). Various attempts were made to induce them to spawn in the laboratory such as subjecting them to mild electric shocks, manupulating the salinity and giving injections of radial nerve extracts of the star fish *Pentaceraster regulus.* Finally success was achieved by thermal stimulation.

On 6-2-'88 at 1030 hrs five specimens of *Holothuria (Metriatyla) scabra* were introduced into 70 litres of sea water at 32°C. The normal temperature of sea water in the laboratory was 27°C under which 10 specimens were maintained as control. Another lot of five specimens were put in sea water at 37°C. After ninety minutes one male in the first lot liberated the sperms in the form of white threads which later got mixed with the sea water. This male was immediately removed and placed in normal sea water to allow it to continue spawning. Simultaneously another male

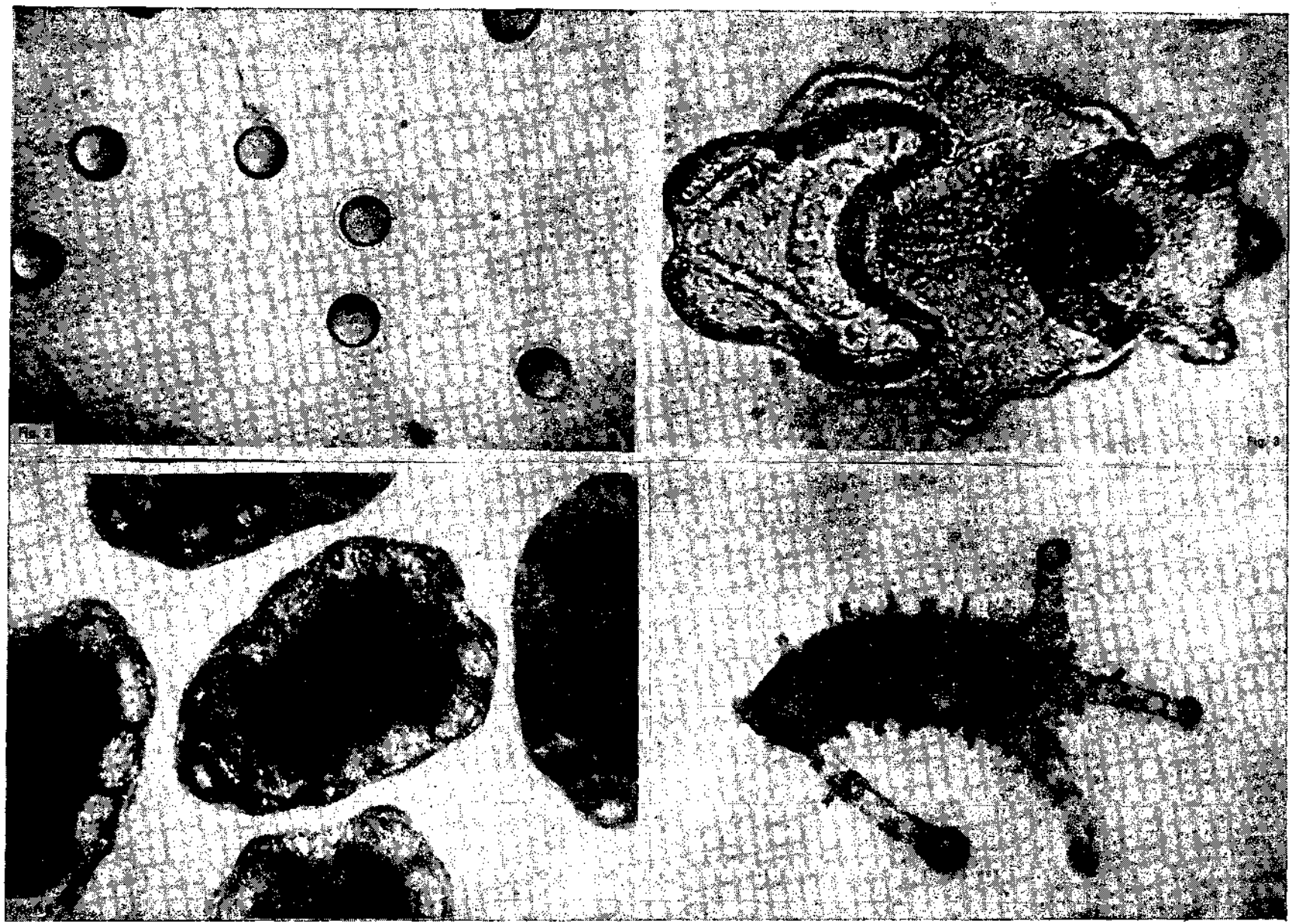


Fig. 2. A group of eggs.
Fig. 4. Doliolaria larva.

Fig. 3. Auricularia larva.
Fig. 5. Pentactula larva.
(*Photographs by:* Mr. M. E. Rajapandian)

under 37°C spawned and this was also put in normal sea water separately. Both the specimens continued to spawn for 15–20 minutes. On completon of spawning the sperm suspension was transferred to a beaker and the same was poured into a tank with sea water of normal temperature. Into this tank the remaining eight specimens were introduced. The sperms induced a female to spawn in a few spurts. The eggs (Fig. 2) were spherical, white and visible to the naked eye and were found floating. The diameter of the eggs varied from 180–200 μ. The number of eggs was estimated at nine lakhs.

After fertilization the eggs underwent cleavage and were transformed into Dipleurula stage which ranged in length from 190–256 μ. The Dipleurula transformed into Auricularia larvae after 24 hours (Fig. 3). They measured 430 μ in length and 280 μ in breadth. The Auricularia were fed on *Isochrysis galbana* and mixed culture dominated by species of diatoms of *Chaetoceros* and *Skeletonema*. The Auricularia larvae actively fed on *Isochrysis galbana*. The mouth region exhibited constant pulsating movements and the yellowish-green concentration of *Isochrysis* in the stomach was seen in circular movement. As days passed on, the Auricularia larvae became more transparent and the lateral projections also became more prominent. On each side there were four lateral projections and at the tip of each projection there was a round structure. The bands also showed a number of pigment spots. The length of the Auricularia larvae at this stage varied from 660 to 1050 μ (average 860μ) and breadth 240–690 μ (average 500 μ). Some of the Auricularia were smaller in size. A few Auricularia transformed into Doliolaria stage (Fig. 4) on the tenth day. The Doliolaria were barrel-shaped with five bands and with two tentacles projecting out. The posterior portion was slightly tapering. On each side there were five round structures with ossicle distinct at the posterior end. There were five groups of cilia like structures on each side. The Doliolaria moved fast in the forward direction. Their length varied from 420–570 μ (average 485μ) and 240 to 390 μ in breadth (average 295 μ).

On the thirteenth day some of the Doliolaria transformed into Pentactula stage (Fig. 5). The body of Pentactula was tubular with five tentacles at the anterior end and with one short stumpy tube-foot at the posterior end. The cloacal opening was distinct. Colour was greenish brown. The length varied from 330 to 750 μ (average 474μ) and breadth from 250 to 400μ (average 307μ). By eighteenth day the tube-feet and tentacles became more distinct and a number of tables were seen in the skin. The tentacles had a web in between them. At the posterior end two long tube-feet were seen. The spires of the tables were projecting out of the skin. The tentacles and tube-feet also had tables sparcely distributed. The length of the specimens varied from 550 to 720 μ (average 656 μ) and breadth varied from 210 to 320 μ (average 262 μ). The Pentactula have the habit of moving to the edge of the tank and remaining just below the surface of water. Soon they settled down to the bottom and started feeding on powdered *Ulva* and *Sargassum*.

The early development of fertilized egg took place on the surface and column of water. From the Dipleurula stage the larvae started feeding on micro-algal cultures. The Auricularia and Doliolaria are planktonic but the Pentactula settles down to the bottom of the tank. The larvae were reared in one tonne tank in filtered and aerated sea water of salinity 32–34‰ and temperature 27–29°C. Water was changed every day. The temperature, pH and salinity were regularly monitored.

Edited by Dr. K. J. Mathew, Mr. I. David Raj and Mr. G. S. D. Selvaraj. Published by Dr. K. J. Mathew on behalf of the Director Central Marine Fisheries Research Institute, Cochin-682 031. Printed at PAICO, Cochin-31.